

EUROPEAN EDITION

EDN

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS WORLDWIDE

PROCESSOR UPDATES
PG 73

7 AUG 1992

A CAHNERS PUBLICATION

JULY 20, 1992

International PRODUCT SHOWCASE



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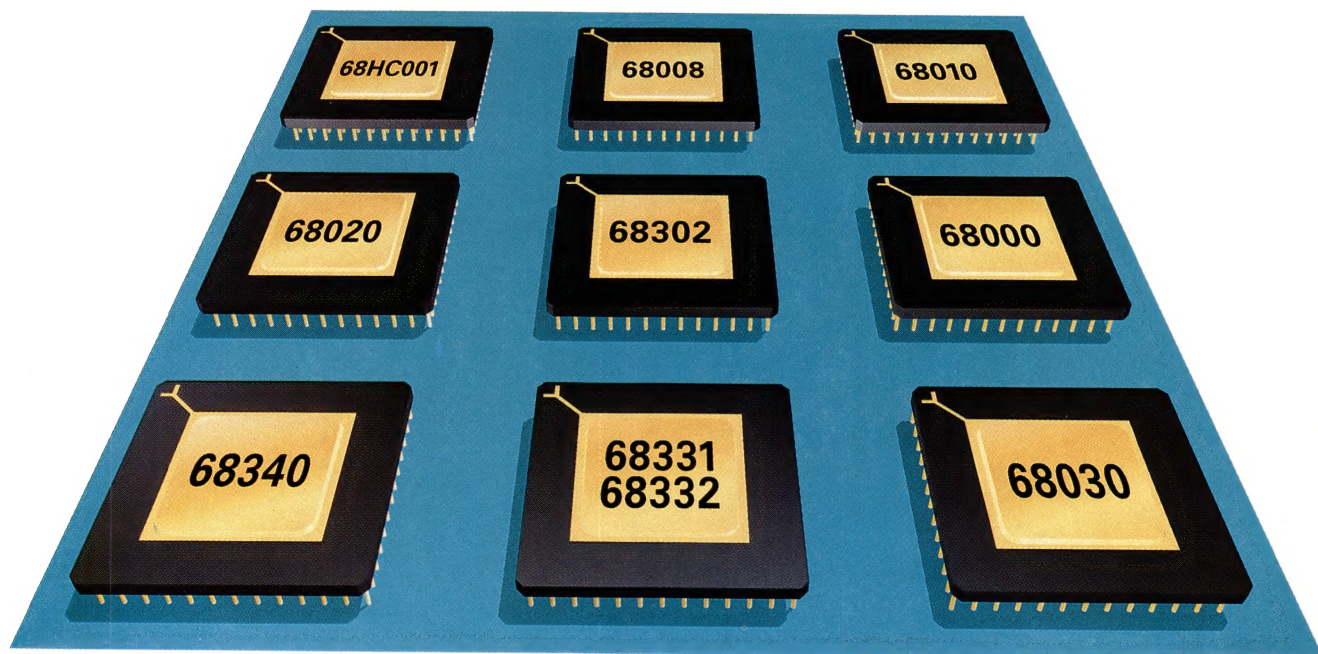
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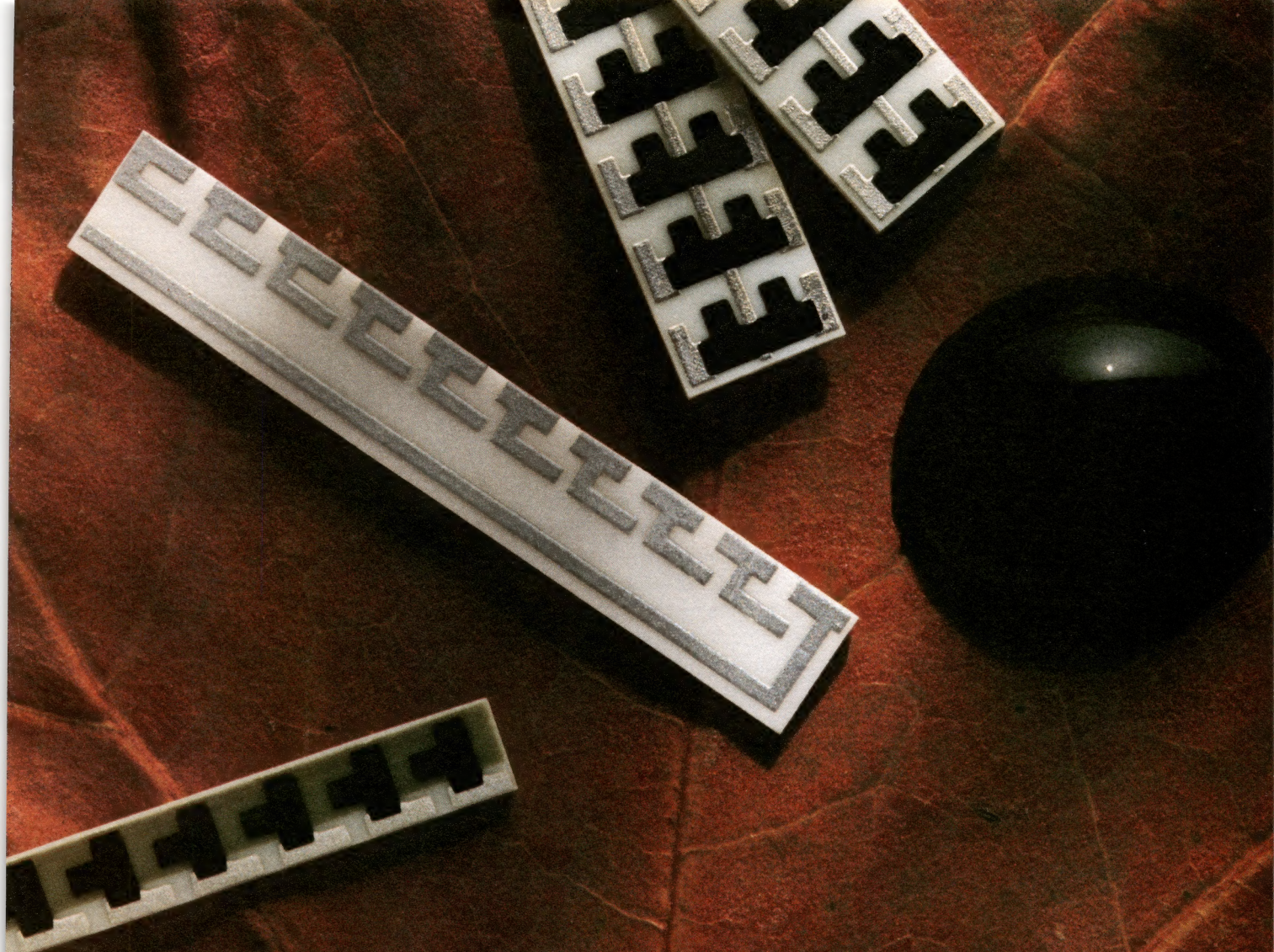
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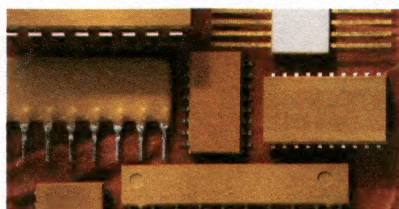


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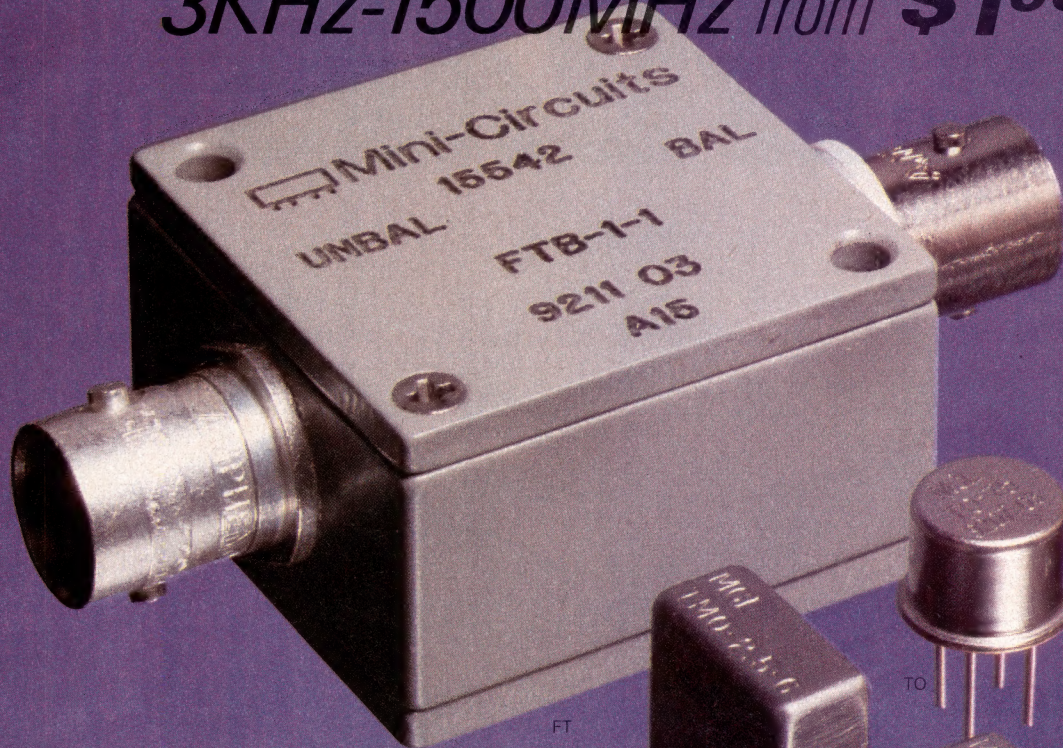


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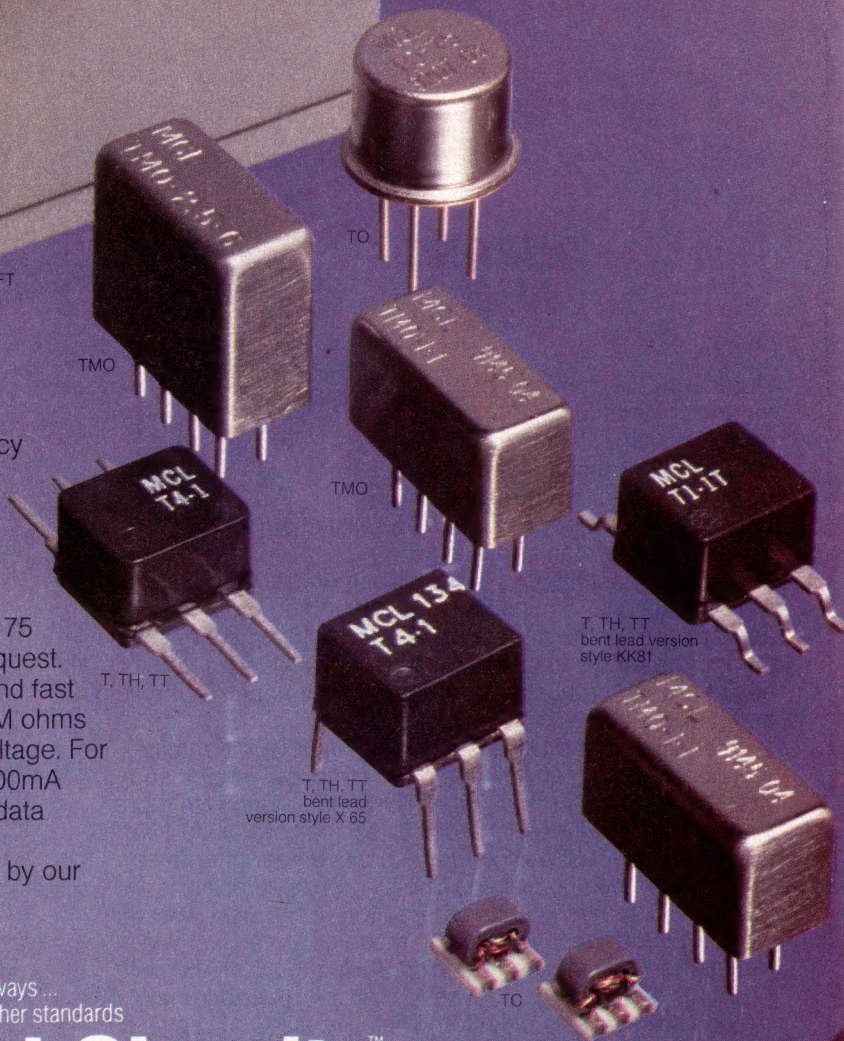
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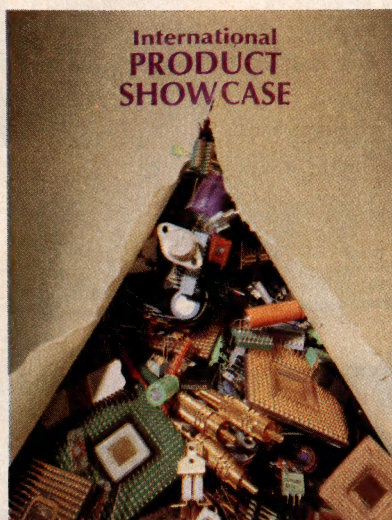
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SBL-1Z	10-1000	6.5	35	25	+7	7.25
SBL-1-1	0.1-400	5.5	35	40	+7	7.25
SBL-3	0.025-200	5.5	45	40	+7	7.25
• SBL-11	5-2000	7.0	35	30	+7	18.75
SBL-1LH	2-500	5.8	68	45	+10	5.50
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• SBL-11LH	5-2000	7.0	45	30	+10	19.75
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On the cover: This Product Showcase brings you up to date on significant products in four categories: components, instruments, computer-aided engineering, and computers and peripherals. Staff-written articles lead off each product section. An analysis of three precision-resistor technologies (pg 86) ushers in the component section. In the instrument area, learn how to avoid the traps inherent in relay signal switching (pg 118). In CAE: why wait weeks for a layout house to create a physical layout when floorplanning tools do it in minutes to hours (pg 154). Finally, we lead off our computers and peripherals section with a look at how distributed control networks create a totally automated environment. (Thanks to Motorola Inc (Chandler, AZ) for providing some of the devices appearing on the cover. Cover photography by John Chomitz; art direction by Ken Racicot and Cathy Madigan)

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS WORLDWIDE

TECHNOLOGY FEATURES

Components

Elegant architectures yield precision resistors

Three precision-resistor technologies produce TCRs of less than 10 ppm/°C. Knowledge of these resistors' constructions will help predict how each type will perform in your circuit.—*Brian Kerridge, Technical Editor*

86

Instruments

Using relays to switch analog signals is neither silly nor trivial

Failing to take the signal switching seriously can be a costly mistake.—*Dan Strassberg, Technical Editor*

118

Computer-Aided Engineering

Floorplanning: layout comes to the logic designer

Using floorplanning tools to do a preliminary physical layout and predict interconnect delays lets you short-circuit the layout-and-resimulate loop.—*John C Napier, Technical Editor*

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Computers and Peripherals

Low-cost control LANs add automation to homes, autos, and offices

From smart houses to industrial automation, control LANs now provide standard protocols and software interfaces to simplify development of automatic distributed control applications.—*Maury Wright, Technical Editor*

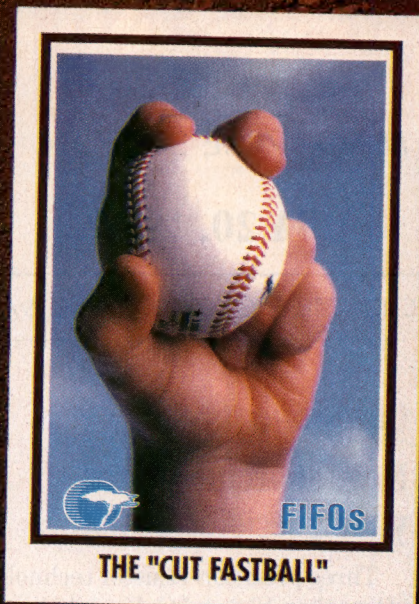
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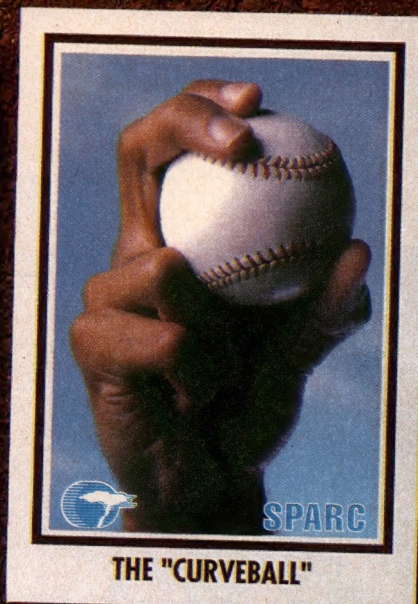
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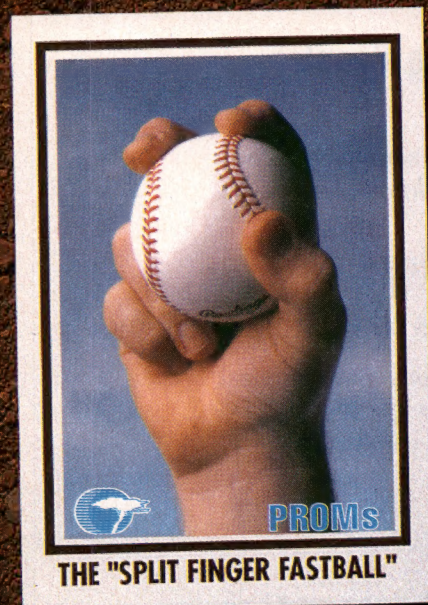
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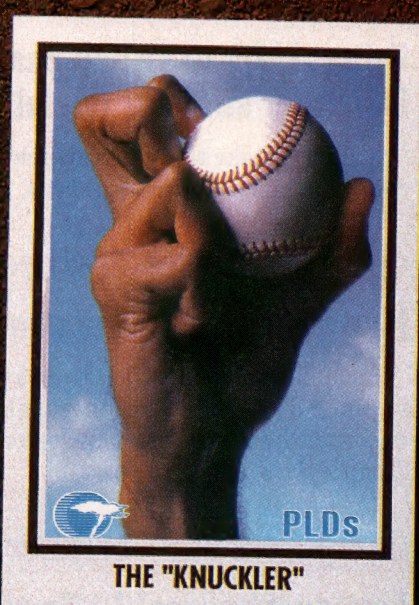
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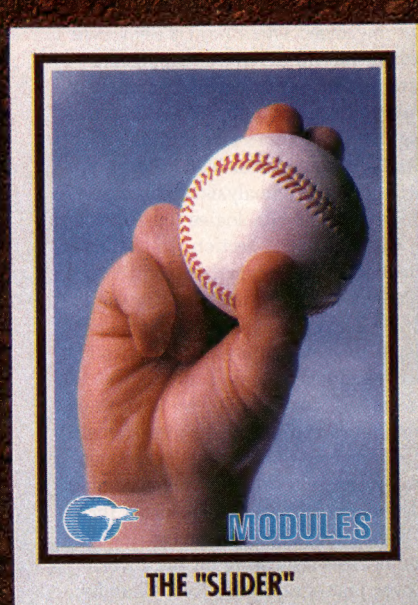
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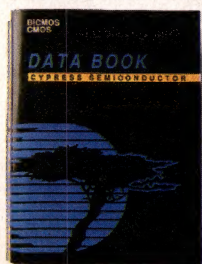


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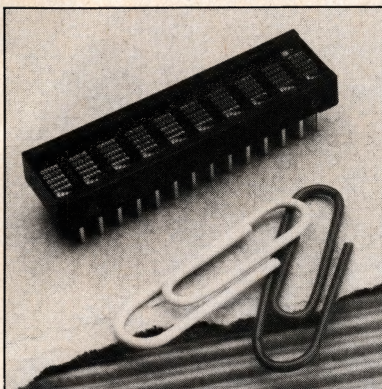
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EDN's editors have reviewed the best products introduced between January and July in four product categories and have compiled them in this issue for your selection. Read all about components (pg 98), instruments (pg 126), computer-aided engineering (pg 163), and computers and peripherals (pg 190).

Log on

Check out EDN's free bulletin-board service (BBS) by dialing (617) 558-4241 (300/1200/2400/9600 8, N, 1). You can download listings, programs, and other material from published articles and from our Design Ideas department. Our editors have put more than 1500 shareware engineering programs on the BBS. We also have a place to submit questions to Ask EDN and a place to speak out on any topic of interest.

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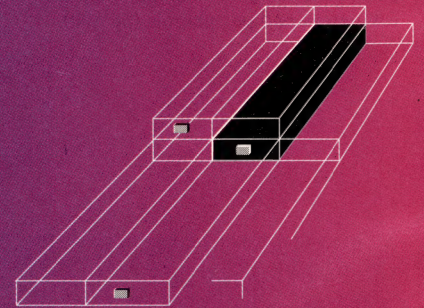
Advanced Cylindrical Sealed Rechargeable Nickel Cadmium Batteries

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			Charging Current (mA)	Time (Hrs.)	L (mm)	W (mm)	T (mm)	
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KF-A900	1.2	900	90	14-16	67.0	17.0	8.1	30
KF-A1200	1.2	1200	120	14-16	67.0	17.0	10.3	38
KF-B600	1.2	600	60	14-16	48.0	17.0	8.1	21
KF-B400	1.2	400	40	14-16	48.0	17.0	6.1	16

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MCI: EDNBOS
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EDITORIAL

Design products, not circuits

The days of circuit designers are numbered. Today's engineers must be product designers, and they have to worry about more than ICs and circuit boards.

—Jon Titus, Editor

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PROFESSIONAL ISSUES

Plug yourself into a network

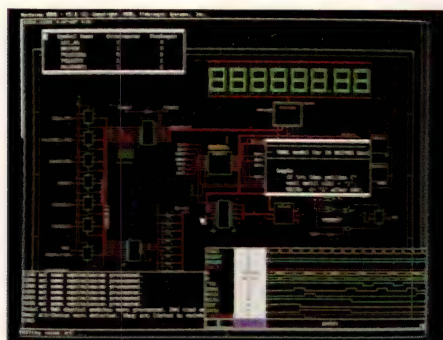
Networking isn't always easy for engineers, but the results are worth the effort.—Jay Fraser, Associate Editor

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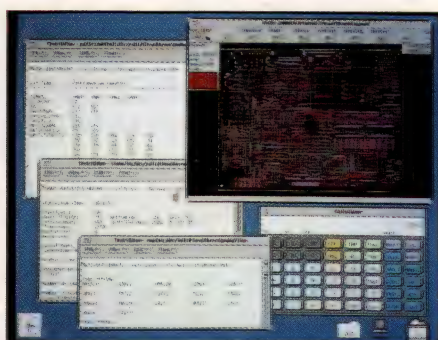
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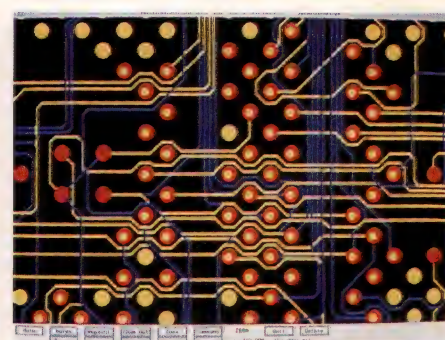
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A summary and analysis of articles in this issue

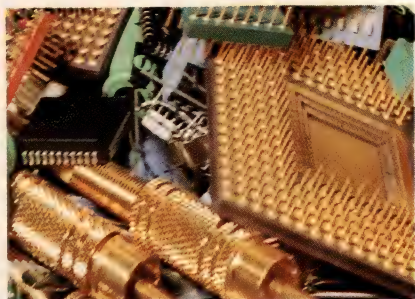
Our second summer showcase issue brings you news of test and measurement instruments, CAE tools, computers and peripherals, and components, as well as Technology Features in each of these areas.

In the test and measurement world, the conventional wisdom holds that switching analog signals using relays requires little talent and less thought. Technical Editor Dan Strassberg says that's dead wrong. In his Technology Feature, Dan warns that **relay signal switching** is filled with traps for the unwary and that if you think the way to avoid relays' problems is to steer clear of the devices, think again.

Because of the characteristics that electromechanical and reed relays possess, they remain more suitable than their solid-state counterparts for switching four classes of analog signals. Read Dan's article to discover which signals fall into these classes and how to avoid trouble when using signal-switching systems such as multiplexers or matrices. Also, check out the sidebar on signal-switching products that use optoFET isolators—solid-state devices—instead of relays. An optoFET isolator combines an LED or LED array and one or more MOSFET switches, or ICs that behave as if they were MOSFETs.

John Napier, EDN's new technical editor, introduces the CAE section with his Technology Feature on **ASIC floorplanning tools**. ASICs' shrinking feature sizes have shifted the focus of the timing budget from gate delays to interconnect delay. In fact, interconnect delay often determines whether a logical design still works after physical layout.

Floorplanners let logic designers do a preliminary physical layout to predict interconnect delays. Logic designers input the timing data to



a simulator for design verification before turning the design over for final place and route. John cautions that three different types of tools lay claim to the term "floorplanner," so you have to read the fine print to know what you're buying.

In his Technology Feature, Technical Editor Maury Wright reports that the advent of two **control LANs** means that you'll soon be able to automate your home, car, office, or small industry site for a reasonable price. Echelon's Lonworks control LAN is suitable for all four applications; and ICs, node modules, routers, repeaters, bridges, and development tools and products are already available. The specifications for the Electronics Industries Association's CEBus (consumer electronics bus) have just emerged, and an IC that can send and receive CEBus signals over ac power lines is available now. Maury says that more CEBus products should appear this year, so start dreaming up your totally automated "smart house."

Technical Editor Brian Kerridge gets down to basics with his Technology Feature on **precision resistors**, which precedes the components product section. The precision resistors Brian covers are foil, wirewound, and thin-film devices. Knowing the details of the resistors' construction will help you understand and predict how each type will perform in your circuit.

Julie Anne Schofield
Senior Associate Editor

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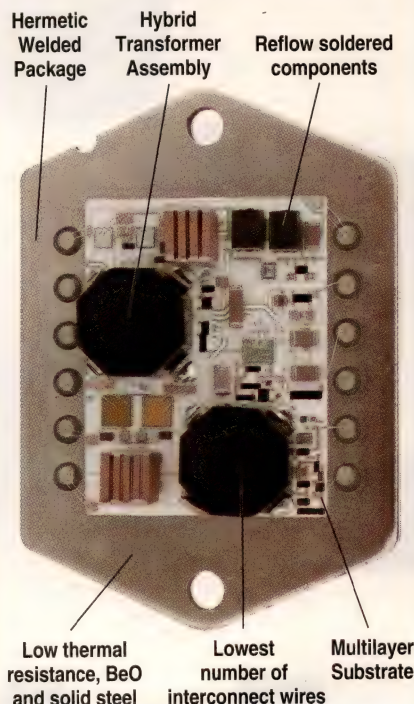
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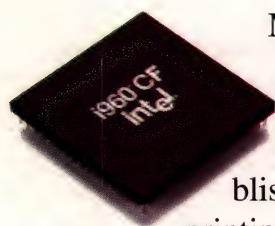


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KM68257B	32KX8		15 ns
KM68257B-L	32KX8	Low Power	20 ns
KM64257A-L	64KX4	Low Power	25 ns
KM64258B	64KX4	OE	15 ns
KM64259B	64KX4	Sep. I/O	15 ns
KM64260B	64KX4	Sep. I/O	15 ns
KM61257A-L	256KXI	Low Power	25 ns
KM6865B	8KX8		15 ns
KM6865B-L	8KX8	Low Power	20 ns
KM6466B	16KX4	OE	12 ns
KM6465B	16KX4		12 ns
KM78C80J	8KXI6 or 4KXI6X2 way	386 Cache RAM	20 ns
KM75C01	512X9	FIFO	15 ns
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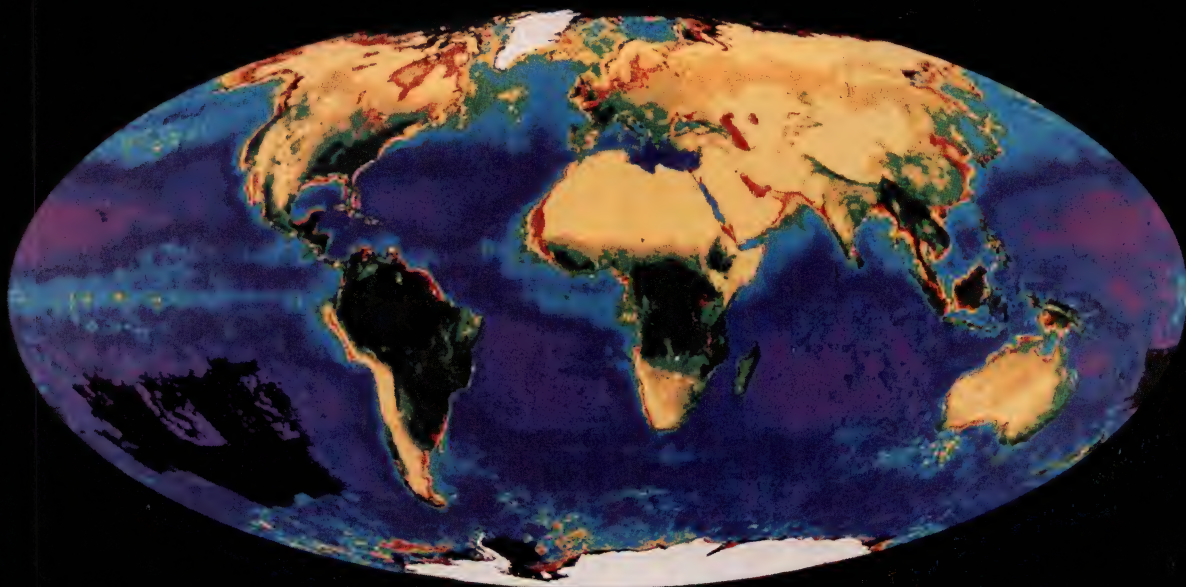
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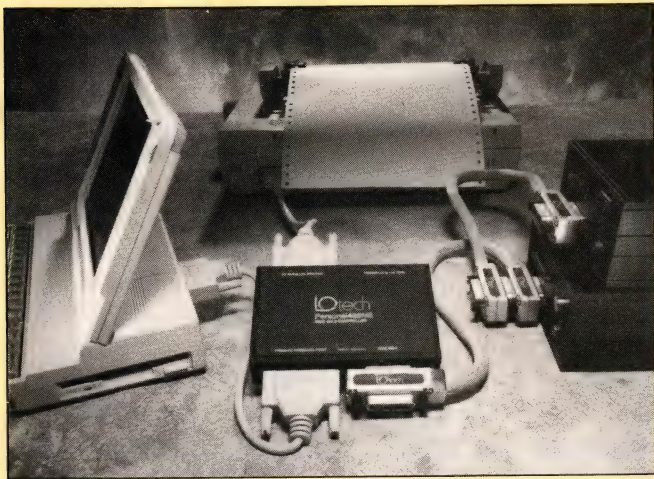


*In Europe, FAX to: (49) 7031-14-1750.

Now notebook PCs can control an IEEE-488 bus

Though you might not think so at first, a notebook-size computer that controls IEEE-488 instruments—even instruments that themselves aren't particularly portable—would be quite useful for a significant number of people. For example, if you are acquiring data in a moving vehicle, one of your main objectives is probably to minimize the number of heavy items you must lug on board.

IOtech's \$495 Personal488NB suits such applications. The 5.5×4×1.5-in. unit plugs into a notebook's parallel port. It generates the bus and replicates the parallel port, so you don't lose the ability to connect a printer. If the PC has a connector for an external keyboard, the interface does not require an ac-power source; the notebook's battery-operated supply will provide the power. However, you can use an ac adapter instead. The bus transfers data at 170 kbytes/sec, approximately 1/5 its maximum speed using conventional hardware. All of the high-level-language software drivers that the vendor has developed for its ISA bus IEEE-488 interfaces work with the notebook interface; the drivers of your choice accompany the hardware. IOtech Inc, Cleveland, OH, (216) 439-4091, FAX (216) 439-4093.



A notebook PC can control an IEEE-488 bus—and a printer—when you connect IOtech's Personal488NB to the computer's parallel port.

Database includes Rs and Cs

CAPS (computer-aided product selection) R/C is a parametrically searchable resistor/capacitor data-

base on CD-ROM that comes with part numbers, specifications, and salient characteristics of approximately 700,000 resistors and capacitors from more than 250 manufacturers. The database is organ-

ized, indexed, and stored on three CD-ROM disks (two index and one image disk). The company will update the disks quarterly.

CAPS R/C works the same way as the CAPS IC and semiconductor database to give engineers instant and local access to complete and current data. CAPS and CAPS R/C are available on an annual subscription basis in DOS and Unix configurations. CAPS R/C will be available in the third quarter of 1992 at an introductory price of \$2500; regular price will be \$2995 annually. Cahners Technical Information Service Div, Newton, MA, (617) 558-4999.

Analog I/O chip simplifies DSP for embedded control

Adding analog I/O capability to a microcontroller can rapidly consume precious board space and I/O-port resources. To ease that problem, Micro Linear has introduced the ML2377 analog I/O chip. The device offers a 10-bit A/D converter, 10- and 8-bit D/A converters, two S/H channels, and a 6-channel multiplexer in a single IC. In addition, the device features data buffers and an interface port for simple connection to DSP μ P, such as the TMS-320C14. The part runs off a single 5V supply and provides a ± 2 V input and output signal range. It comes in a 44-pin quad

flatpack and costs \$6.50 (1000). Samples are available now; production is scheduled for August. Micro Linear Corp, San Jose, CA, (408) 433-5200, contact David Wong.

1.5-Gbs fiber link costs less than \$1000

A proprietary approach to modulating laser diodes has let Finisar Corp produce a high-speed fiber-optic data link that uses multimode fiber and laser diodes. By utilizing multimode devices, the company cut the cost of its fiber link to \$670 per node, plus fiber costs. The multimode system is also more tolerant of connector and fiber mismatches than existing single-mode links, providing a more robust system.

The FTM-8500 and FRM-8500 transmitter and receiver modules can exchange data over distances of 500m at rates ranging from 100 Mbps to 1.5 Gbps. The link's error rate is $<10^{-12}$ with an operating lifetime of $>200,000$ hours. Together with a link controller IC, the modules can also monitor and control the link's status without the need for optical test equipment. The controller automatically provides information such as optical power levels, drive currents, and transmitter temperature. Finisar Corp, Menlo Park, CA, (415) 364-2722, FAX (415) 364-3042, contact Jerry Rawls.

3V linear devices keep up with digital ICs

To keep pace with the low-voltage developments in digital devices for portable and battery-powered equipment, linear-circuit vendors are now supplying low-voltage components. Depending on their common-mode range and minimum-rated supply voltage, a few linear devices can already work at low voltages, but very few have actual characterized performance for supplies below 5V. Texas Instruments is among the first to announce a 3V-characterized linear family. The TLV 10-device family comprises single, dual, and quad op amps, dual and quad comparators, and a 3.3V low-dropout voltage regulator that meets the JEDEC 3.3V standard. The company characterizes the performance of the op amps and comparators at both 3 and 5V supply voltages, but these devices will work with supply voltages as low as 2V. The common-mode input range of the op amps extends below the negative rail, which is typically ground, and within 1V of the positive rail at 25°C.

The op amps include a bias-select feature that lets you trade off ac performance for power dissipation. You can either specify different versions for the dual and quad op amps or set the supply current of the single op amp to 17, 250, or 1500 μ A. The slew rates for these bias selections are between 0.02 and 2.1V/ μ sec, and unity-gain bandwidths are between 27 and 790 kHz (all typical specs at 3V). The devices are available in DIPs, SOICs, and TSSOPs (thin small-scale outline packages), and prices for the family range from \$0.54 (single op amp) to \$1.69 (quad op amp). Texas Instruments Inc, Semiconductor Group, Dallas, TX, (214) 995-6611, ext 3990.

Design contest offers notebook-PC prize

Apex Microtechnology Corp is looking for some good design ideas that incorporate its PB50 and PB58 high-voltage boosters. These devices act like buffers and can boost the output of a small-signal system to high-voltage and high-current levels. The boosters can potentially replace op amps in a variety of applications involving DACs, instru-

mentation amplifiers, multipliers, and dividers, and the company is after some novel circuit applications. All entries must be received by October 15, 1992. The winning designer receives a 386TFX25 PC Notebook with 4 Mbytes of RAM, a 60-Mbyte hard-disk drive, and a 10-in. monitor. For this contest, the company's evaluation kits, which include a heat sink, pc board, mating socket, and hardware, are free. However, evaluation units aren't free; the PB50 and PB58 cost \$54.90 and

\$64.90, respectively. These are special prices for the contest only, and the offers expire on August 31, 1992. For contest guidelines and entry forms, contact Marie Rivera at Apex Microtechnology Corp, Tucson, AZ, (602) 690-8603, FAX (602) 888-3329.

Disk-drive motor controller replaces five ICs

The TDA5340/5341 brushless dc motor drivers incorporate both spindle and actuator drive circuitry and integrate the functions of as many as five components in hard-disk electronics. The devices come in a shrink quad flatpack (SQFP) that measures 1.4 mm high. The ICs can replace a separate spindle controller with power field-effect transistors, a voice coil, motor controller and driver, and power drivers. The devices can drive full-wave brushless dc motors without commutation sensors because they use a frequency-sensing technique to position the rotor.

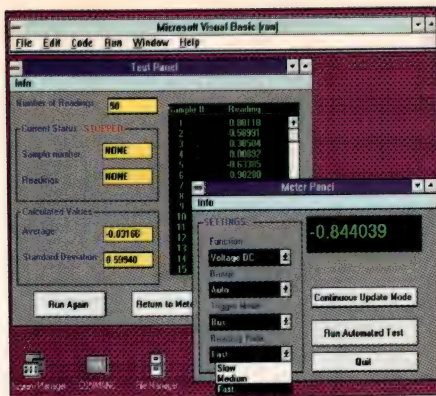
The drivers also include start-up circuits, automatic park procedures, which avoid a head crash if power is lost, and a reset signal generator. The TDA5341 version includes a frequency-locked loop to control rotor speeds to 6000 rpm. The drivers operate from 5V, and maximum spindle-drive current is 1.6A, which reduces to 200 μ A in sleep mode. The TDA5340, in a 48-pin plastic package, costs \$7.80;

the 5341, in a 64-pin plastic package, costs \$8.85. Philips/Signetics, Sunnyvale, CA, (408) 991-2000.

JPEG chip set allows picture preview

The 040 2-chip set implements the JPEG (Joint Photographic Experts Group) image-compression standard, including the ability to read files encoded by other JPEG systems. The set also has features beyond the image-compression standard. For example, you can program the chips to control the compression bit rate, letting you target a compressed image to a fixed memory size. Without bit-rate control, the compressed-image file size varies with picture content.

The set also lets you preview compressed images at less than full resolution. The decompression speed for the preview mode is 10 \times the speed of normal decompression, letting you quickly scan the images on a file. Not that the normal decompression speed is slow. The chip set comes in 15- and 21-Mbyte/sec speed grades, fast enough to handle 720 \times 480-pixel images at the motion-video rate of 30 frames/sec. Together, the devices cost \$99 in small quantities; the price drops to \$49 for volume production (10,000). Zoran Corp, Santa Clara, CA, (408) 986-1314, contact Dr Isaac Shenberg.



NI-488.2™ software for Windows and DOS



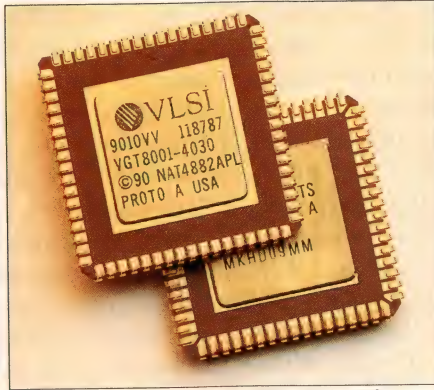
IEEE 488.2 interfaces for PC/XT/AT/EISA, PS/2, and Macintosh



IEEE 488 interfaces for desktop workstations



Bus extenders and expander/isolator



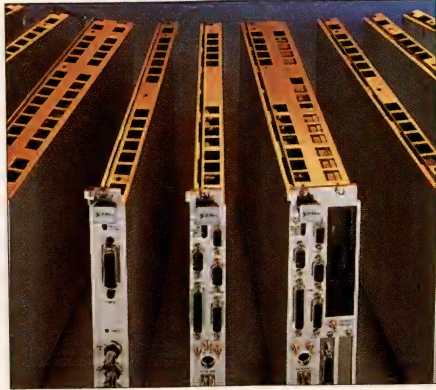
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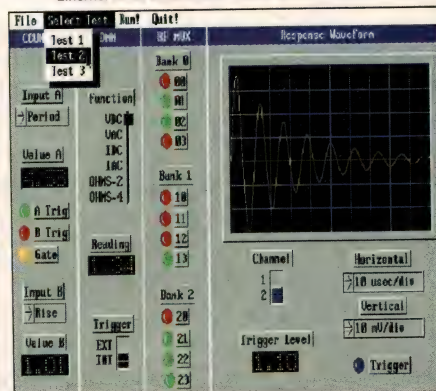
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Tool lets you perform design automation in Unix

Viewlogic's Powerview is the company's first Unix-based design-automation tool. The company claims that this software is the first commercial product that's compatible with the electronic-design-automation standard CFI 1.0 (CAD Frameworks Initiative 1.0) as it currently stands. The software also uses Openlook, Motif, and EDIF 2.0.0. The tool set includes design entry, simulation and verification, synthesis and targeting, and layout integration.

The tools let you use a range of design-entry methods, including VHDL (VHSIC Hardware Description Language), Abel, truth tables, state diagrams and tables, functional block diagrams, and schematics. You can also enter designs through the waveform editor and the graphical VHDL entry tool, Envision VHDL. The simulator (Viewsim XL) combines VHDL simulation and debugging with mixed analog (Spice) and digital simulation. It also runs 10× faster than the current Viewsim simulator. Other tools include a VHDL-logic-synthesis package; in addition, a package that facilitates migrating existing designs in PLDs to new technologies, called ViewPLD, maps JEDEC, Abel, CUPL, and Palasm formats into field-programmable gate arrays. The set includes incremental netlisting for making changes after compiling designs; save-and-restore for stopping and resuming simulations; circuit-level optimization; Kanji support; complete on-line documentation; and the ability to recognize and respond to mouse-drawn figures.

Each tool of the set comes in the form of an executable program, regardless of function. Each program is invoked by a shell that maps the invocation syntax into icons and stores each tool definition in its own file. Therefore, you can integrate any tool that can be invoked from a system window into the software, including third-party and user-developed tools. The tool set runs on SPARCstations from Sun Microsystems and is data compatible with Viewlogic's Workview tools for DOS-based platforms. Minimum hardware is SPARCstation 2 with 32 Mbytes of RAM. The company is also developing HP- and DEC-workstation versions. Depending on configuration, prices range from \$26,500 to \$70,000. Viewlogic Corp, Marlborough, MA, (508) 480-0881, FAX (508) 480-0882.

Digital ICs have radiation-hardened features

CMOS logic, RS-422 interface ICs, and static RAMs (SRAMs) are now available with radiation-hardened

features from Harris Semiconductor. The ACS/ACTS CMOS Class-S logic family will eventually contain more than 100 parts that suit space applications using fast-access-time RAMs and high-speed μ Ps. The devices are CMOS and silicon-on-sap-

phire versions of AC and ACT logic. Features of the devices initially include an ACS03 quad NAND gate, ACTS240 inverting and ACTS244 noninverting, 3-state, octal buffers/line drivers, and an ACTS245 3-state, octal bidirectional transceiver. The parts' total-dose hardness exceeds 1M RAD, and single-event upset error rates are less than 10^{-10} errors/bit-day. Typical transition times are 4 nsec, and maximum propagation delays range from 6 to 11 nsec. Static power dissipation for each device is less than 4.1 mW. Prices range from \$200 to \$250 (100).

The HS-26C31RH and HS-26C32RH quad line driver and receiver, respectively, are pin compatible with Advanced Micro Devices' LS devices with stand-by power dissipations of 2.75 and 100 mW compared with 440 and 385 mW for the LS versions. These interface ICs, although fabricated from a different CMOS process than the previous logic ICs, can also withstand total radiation doses of 1M RAD and operate from a single 5V supply. Pricing for the driver and receiver is \$275 and \$290 (100), respectively. You can also currently place limited production orders of a 256-kbit, 25-nsec SRAM, the HS-65758RH. Built using the company's latest radiation-hardened digital process, price for this device ranges from \$3000 to \$4000, depending on configuration and quantity. Harris Semiconductor, Melbourne, FL, (800) 442-7747.

Software builds human-interface prototypes

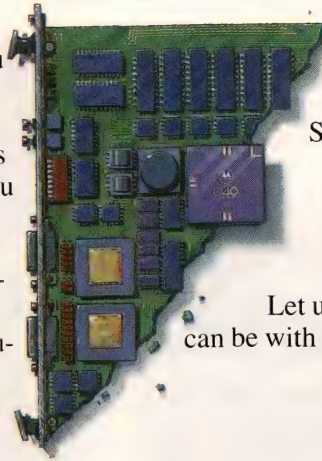
Avid Design provides human-interface prototypes for instrument and control-systems developers. The tool's mouse-driven graphical design abilities eliminate the need to write graphics code. The software replicates the look and behavior of dials, meters, sliders, buttons, CRT displays, strip charts, and custom components. Therefore, it can replace physical prototypes with accurate software simulations.

The software solves a problem for instrument developers by letting them try out the user interface of a new product and modifying it until it's right. The developer can show an interface to an evaluator and then, in response to suggestions, change the interface within minutes, and find out from the evaluator whether the changes are what he or she wants. The old method (going back to the lab and constructing a new or modified prototype) had the major disadvantage that, by the time the modified user interface existed, the evaluator had often forgotten what the problems were with the previous version. The \$4900 software is available in versions for most Sun and HP workstations. Site license and OEM pricing is also available. Altia Inc, Colorado Springs, CO, (719) 598-4299.

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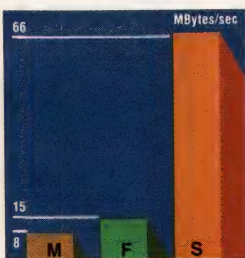


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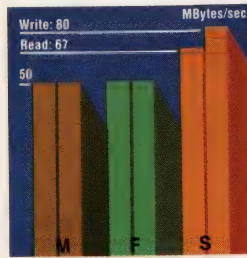
Compare our specs. Synergy is superior across the board!



VME Transfers

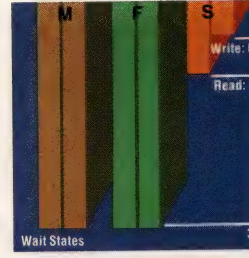
VME64 doubles bus performance to 66 MB/s—and the SV430 is the only '040 board that has it. But we don't need VME64 to win this comparison.

Even normal 32-bit transfers race at 33 MB/s. That's 200% faster than Force or Motorola.



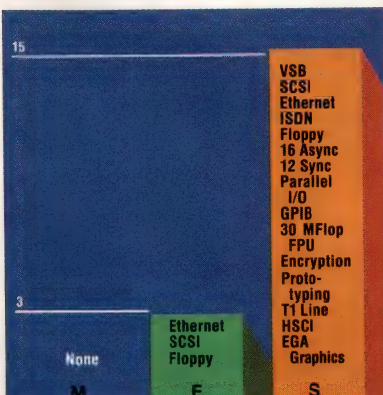
DRAM Burst Rates

A 25 MHz '040 is capable of accessing memory at 80 MB/s. The closer you are to this maximum, the more '040 performance you're gaining. SV430 bursts are 26% faster than Force and Motorola.



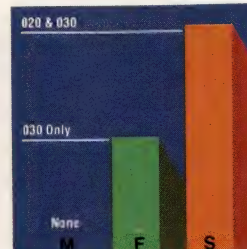
DRAM Random Accesses

Non-burst '040 performance is measured in wait states. Fewer wait states mean higher performance. The SV430 is not only 66% faster than Force or Motorola, it supports twice the on-board memory—32 MB.



I/O Modules

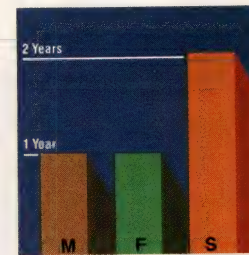
Synergy's EZ-Bus modules are compatible with our entire line of SBCs. This means Synergy's current line of 12 intelligent I/O modules are immediately available for the SV430—today. No other vendor comes close for selection, functionality or availability.



'020/'030 Compatibility

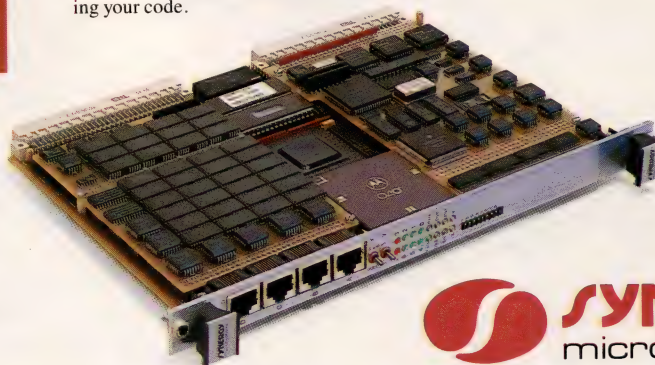
Software compatibility between Synergy SBCs means users have simple upgrades to the SV430 from our '020 and

'030 SBCs. Force offers compatibility only from the '030 level, and Motorola offers "upward migration"—a polite phrase that means rewriting your code.



Product Warranty

Synergy backs the reliability of its SBCs with a two year standard warranty. Force and Motorola only offer you one.



Data from Motorola MVME165 data sheet dated 2/90, and Force CPU-40 data sheet A1 Rev. 1. DRAM measurements shown are with parity. VMEbus transfers are to a 60ns slave.

VME64 is a trademark of Performance Technologies, Inc.

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low pass, Plug-in, dc to 1200MHz

Model No.	Passband MHz	Stopband, MHz	Model No.	Passband MHz	Stopband, MHz
	loss < 1dB	loss > 20dB		loss < 1dB	loss > 20dB
PLP-5	DC-5	8-10	PLP-250	DC-225	320-400
PLP-10.7	DC-11	19-24	PLP-300	DC-270	410-550
PLP-21.4	DC-22	32-41	PLP-450	DC-400	580-750
PLP-30	DC-32	47-61	PLP-550	DC-520	750-920
PLP-50	DC-48	70-90	PLP-600	DC-680	840-1120
PLP-70	DC-60	90-117	PLP-750	DC-700	1000-1300
PLP-90	DC-81	121-137	PLP-800	DC-720	1080-1400
PLP-100	DC-98	146-189	PLP-850	DC-760	1100-1400
PLP-150	DC-140	210-300	PLP-1000	DC-900	1340-1750
PLP-200	DC-190	290-390	PLP-1200	DC-1000	1620-2100
		300-800			2100-2500

Price, (1-9 qty), all models: plug-in \$14.95, BNC \$32.95, SMA \$34.95, Type N \$35.95

Surface-mount, dc to 570MHz

Model No.	Passband MHz	Stopband, MHz	Model No.	Passband MHz	Stopband, MHz
	loss < 1dB	loss > 20dB		loss < 1dB	loss > 20dB
SCLF-21.4	DC-22	32-41	SCLF-190	DC-190	290-390
SCLF-30	DC-30	47-61	SCLF-380	DC-380	580-750
SCLF-45	DC-45	70-90	SCLF-420	DC-420	750-920
SCLF-135	DC-135	210-300			920-2000
		300-600			

Price, (1-9 qty), all models: \$11.45

Flat Time Delay, dc to 1870MHz

Model No.	Passband MHz	Stopband MHz	VSWR	Group Delay Variations, ns
	loss < 1.2dB	loss > 10dB	Freq. Range, DC thru 0.2fco	Freq. Range, DC thru 2fco
PBLP-39	DC-23	78-117	1.3:1	0.7
PBLP-117	DC-65	234-312	1.3:1	0.35
PBLP-156	DC-94	312-416	0.3:1	0.3
PBLP-200	DC-120	400-534	1.6:1	0.4
PBLP-300	DC-180	600-801	1.25:1	0.2
PBLP-467	DC-280	934-1246	1.25:1	0.15
▲BPL-933	DC-560	1866-2490	1.3:1	0.09
▲BPL-1870	DC-850	3740-6000	1.45:1	0.05

Price, (1-9 qty), all models: plug-in \$19.95, BNC \$36.95, SMA \$38.95, Type N \$39.95

NOTE: ▲: -933 and -1870 only with connectors, at additional \$2 above other connector models.

high pass, Plug-in, 27.5 to 2200MHz

Model No.	Stopband MHz	Passband MHz	VSWR	Model No.	Stopband MHz	Passband MHz	VSWR
	loss < 40dB	loss < 20dB	Pass-band Typ.		loss < 40dB	loss < 20dB	Pass-band Typ.
PHP-25	DC-13	13-19	27.5-200	PHP-400	DC-210	210-290	395-1600
PHP-50	DC-20	20-26	41-200	PHP-500	DC-280	280-365	500-1600
PHP-100	DC-40	40-55	90-400	PHP-600	DC-350	350-440	600-1600
PHP-150	DC-70	70-95	133-600	PHP-700	DC-400	400-520	700-1800
PHP-175	DC-70	70-105	160-800	PHP-800	DC-445	445-570	780-2000
PHP-200	DC-90	90-116	185-800	PHP-900	DC-520	520-660	910-2100
PHP-250	DC-100	100-150	225-1200	PHP-1000	DC-550	550-720	1000-2200
PHP-300	DC-145	145-170	290-1200				

Price, (1-9 qty), all models: plug-in \$14.95, BNC \$36.95, SMA \$38.95, Type N \$39.95

bandpass, Elliptic Response, 10.7 to 70MHz

Model No.	Center Freq. (MHz)	Passband I.L. 1.5 dB Max. (MHz)	3 dB Bandwidth Typ. (MHz)	Stopbands I.L. > 20dB at MHz	Model No.	Center Freq. MHz	Passband MHz loss < 1dB	Stopband loss > 20dB at MHz	VSWR 1.3:1 Total Band MHz
PBP-10.7	10.7	9.6-11.5	8.9-12.7	7.5 & 15	PIF-21.4	21.4	18-25	1.3 & 150	DC-220
PBP-21.4	21.4	19.2-23.6	17.9-25.3	15.5 & 29	PIF-30	30	25-35	1.9 & 210	DC-330
PBP-30	30.0	27.0-33.0	25-35	22 & 40	PIF-40	42	35-49	2.6 & 300	DC-400
PBP-60	60.0	55.0-67.0	49.5-70.5	44 & 79	PIF-50	50	41-58	3.1 & 350	DC-440
PBP-70	70.0	63.0-77.0	68.0-82.0	51 & 94	PIF-60	60	50-70	3.8 & 400	DC-500
					PIF-70	70	58-82	4.4 & 490	DC-550

Price, (1-9 qty), all models: plug-in \$18.95, BNC \$40.95, SMA \$42.95, Type N \$43.95

Constant Impedance, 21.4 to 70MHz

Model No.	Center Freq. MHz	Passband MHz loss < 1dB	Stopband loss > 20dB at MHz	VSWR 1.3:1 Total Band MHz
PIF-21.4	21.4	18-25	1.3 & 150	DC-220
PIF-30	30	25-35	1.9 & 210	DC-330
PIF-40	42	35-49	2.6 & 300	DC-400
PIF-50	50	41-58	3.1 & 350	DC-440
PIF-60	60	50-70	3.8 & 400	DC-500
PIF-70	70	58-82	4.4 & 490	DC-550

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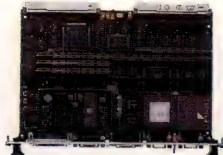
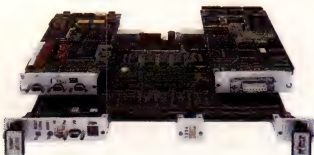
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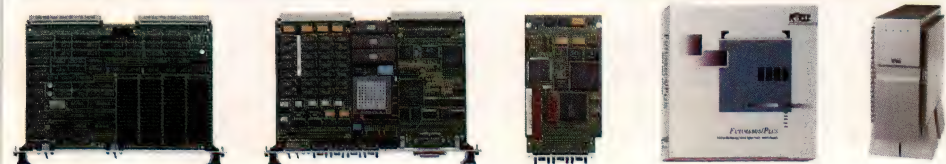
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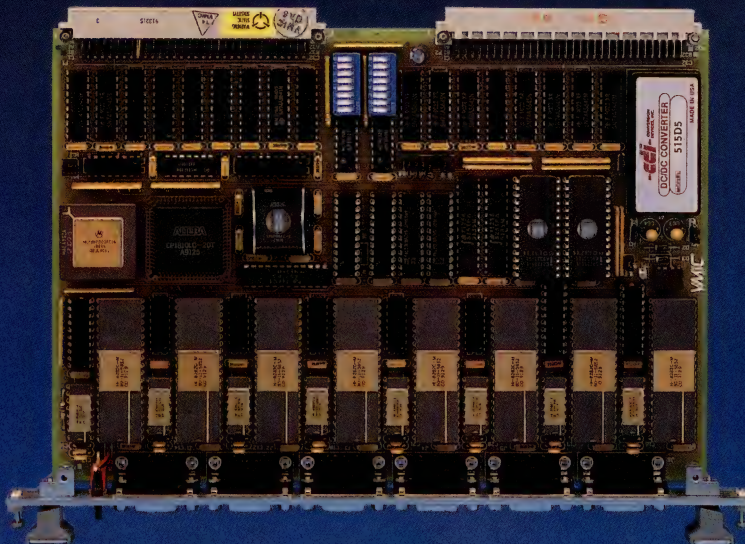
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Correcting impression of programming in Russia

I'd like to comment on Jon Titus's editorial, "USSR electronics; it's not hardware" (EDN, November 21, 1991, pg 35). Unfortunately, this issue was delayed in arriving, so my comments may have lost some of their significance.

Nevertheless, I'd like to correct Titus's impression about Russia as a "programmer's" country. Many hardware engineers are using chips from Western companies in designs, and our board-level products lag no more than one year behind. This time lag will shrink with the extension of distributors' networks, such as Intel, Motorola, Texas Instruments, etc, and the increased availability of company information.

The distributors offer microprocessors, memory, peripherals, and other products for rubles; because the exchange rate is almost settled, more and more electronic-equipment manufacturers will [incorporate] Western components and standards.

To promote this trend, several Russian companies founded VERA (VMEbus and Extensions Russian Association). These companies are working closely with VITA Europe. We are distributing VITA's publications and are providing consulting services for designers and manufacturers.

Alexey Demyanov
President, AVD Systems
VERA Experts Group Manager
Moscow, Russia

Filling the gap with ABT

I'd like to add some comments about ABT (Advanced BiCMOS Technology) to the article, "Piece-wise analysis and accurate emulation yield precise power estimates" (EDN, March 16, 1992, pg 113).

William Hall and Ray Mentzer did an excellent job presenting what truly happens in the system-IC interface. They addressed the

Fast, BCT (not truly BiCMOS), and Fact families, but the ABT family of parts was not mentioned. (That's like discussing the best basketball players of all time and failing to mention Michael Jordan.) The ABT process is a truly integrated bipolar-CMOS process. If ABT had been chosen to represent BiCMOS power consumption rather than BCT products, results would have been markedly different.

An ABT245, for instance, has databook maximum limits of $I_{CCL} = 30$ mA (90 mA for BCT); $I_{CCH} = 50$ μ A (57 mA for BCT); and $I_{CCZ} = 50$ μ A (15 mA for BCT). As one can see, ABT draws much less static current than does BCT. Taking the comparison one step further—ABT vs Fact—would show ABT to be very close to (possibly better than) Fact. (Keep in mind that ABT drives heavier loads, is more noise immune, and is much faster than CMOS.) True BiCMOS (ABT) does indeed have C_{PD} values, because ABT is built with CMOS internal circuitry. ABT can be treated much like CMOS when estimating power dissipation.

Lance K Packer
Applications Engineer
Synetics Co
Orem, UT

HAVE YOUR SAY

EDN's Signals & Noise column provides a forum for readers to express their opinions on issues raised in the magazine's articles or on any topic that affects the engineering industry. Send your letters to Signals & Noise Editor, EDN Magazine, 275 Washington St, Newton, MA 02158. You can also send a note via MCI mail at EDNBOS or use EDN's bulletin-board system at (617) 558-4241. From the Main System Menu, enter SS/SOAP-BOX, then W to write us a letter. You'll need a 9600-bps (or less) modem and a communications program set for 8,N,1.

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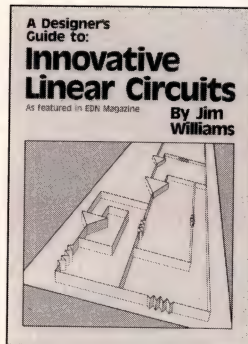
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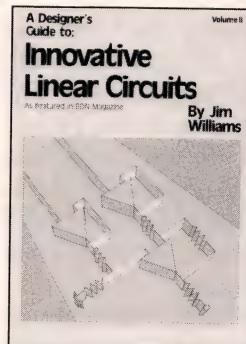
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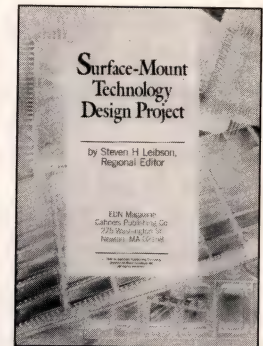


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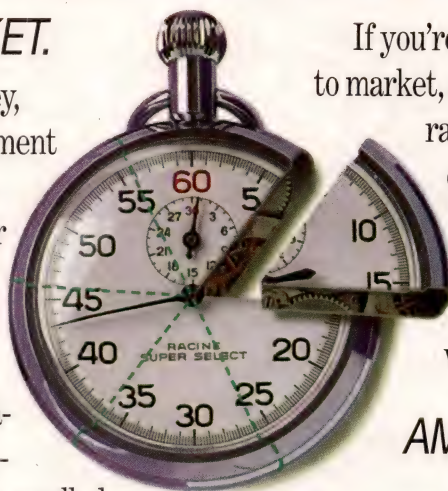
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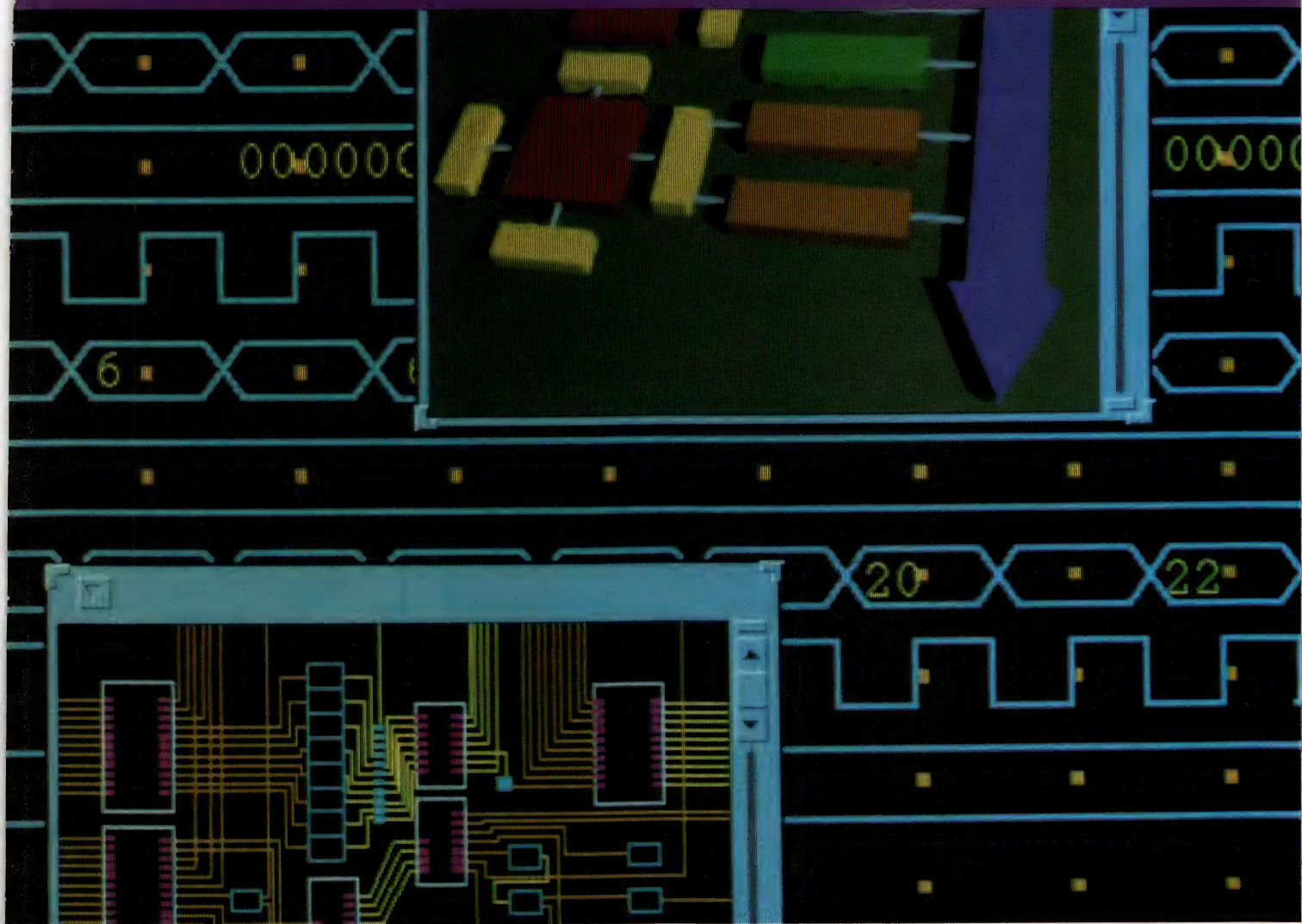
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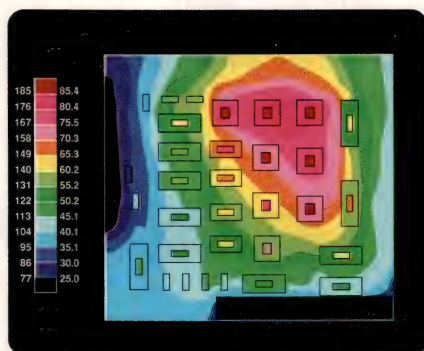
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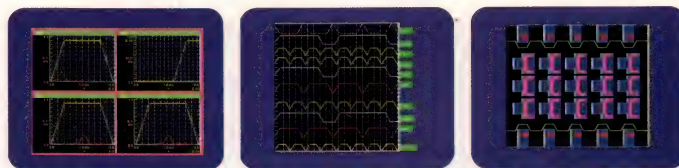


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Computational Learning Theory (workshop), Pittsburgh, PA. Robert Daley, University of Pittsburgh, Dept of Computer Science, Pittsburgh, PA 15260. Phone (412) 624-5930. July 27 to 29.

International Conference on Factory Automation, York, England. IEE Secretariat, Conference Services, Savoy Pl, London WC2R 0BL, UK. Phone (071) 240-1871, ext 222. FAX (071) 497-3633. TLX 261176. July 27 to 29.

Summer Computer Simulation Conference, Reno, NV. Society for Computer Simulation, Box 17900, San Diego, CA 92177. Phone (619) 277-3888. July 27 to 30.

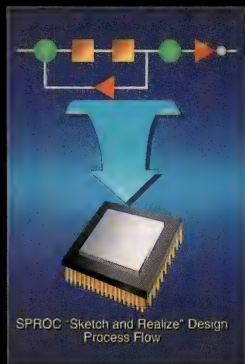
AIAG Statistical Process Control Overview (seminar), Troy, MI. Cliff Carroll, Technology & Training Group, 580 Kirts Blvd, Suite 310, Troy, MI 48084. Phone (800) 346-9533; (313) 244-9870. July 30.

National Association of Scientific Materials Managers Conference & Trade Show, Philadelphia, PA. Barbara Neff, 92 Host, St Joseph's University, Chemistry Dept, Philadelphia, PA. Phone (215) 660-1790. August 3 to 7.

Fed Micro '92: Microcomputer Conference & Exposition, Washington, DC. National Trade Productions, 313 S Patrick St, Alexandria, VA 22314. Phone (800) 638-8510; (703) 683-8500. FAX (703) 836-4486. August 5 to 6.

Design of Fiber Optic Communication Systems (short course), Madison, WI. University of Wisconsin—Madison, Dept of Engineering Professional Development, 432 N Lake St, Madison, WI 53791. Phone (800) 462-0876; (608) 263-3160. August 10 to 12.

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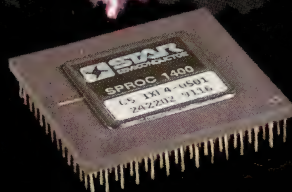
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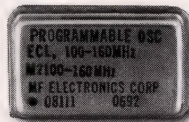
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Symposium in Principles of Distributed Computing, Vancouver, BC, Canada. Norm Hutchinson, University of British Columbia, Dept of Computer Science, 6356 Agriculture Rd, Vancouver, BC V6T 1Z2, Canada. Phone (604) 822-8188. August 10 to 12.

Parallel Digital Signal Processing (short course), Los Angeles, CA. UCLA Extension, Dept of Engineering and Information Systems, 10995 Le Conte Ave, Suite 542, Los Angeles, CA 90024. Phone (310) 825-3344. FAX (310) 206-2815. TWX 910-342-7597. August 10 to 13.

PC/Canada, Toronto, ON, Canada. Cheryl Delgreco, The Interface Group, 300 First Ave, Needham, MA 02194. Phone (617) 449-6600. August 12 to 14.

Windows & OS/2 Conference, Boston, MA. CM Ventures Inc, 5720 Hollis St, Emeryville, CA 94608. Phone (415) 601-5000. FAX (415) 601-5075. August 12 to 14.

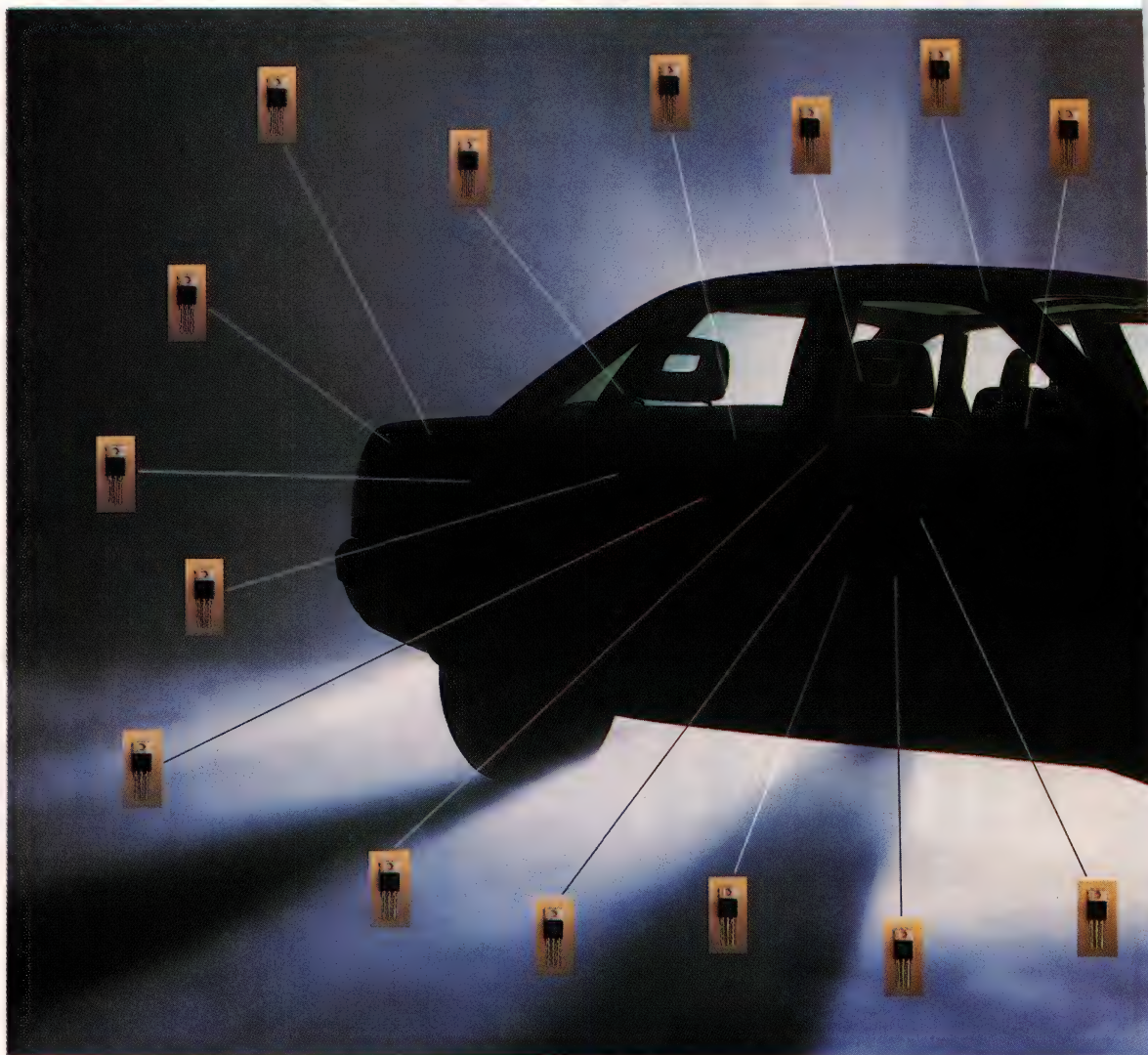
International BBS and Electronic Communications Conference, Denver, CO. IBECC, Box 486, Louisville, CO 80027. Phone (303) 426-1847. FAX (303) 429-0449. August 13 to 16.

International Conference On Crystal Growth, San Diego, CA. CD Brandle, AT&T Bell Laboratories, 600 Mountain Ave, 7C-403, Murray Hill, NJ 07974. Phone (908) 582-6136. FAX (908) 582-5917. August 16 to 22.

International Conference on Intelligent Systems Engineering, Edinburgh, Scotland. ISE 92, Conference Services, IEE, Savoy Pl, London WC2R 0BL, UK. Phone (071) 240-1871, ext 222. FAX (071) 497-3633. August 19 to 21.

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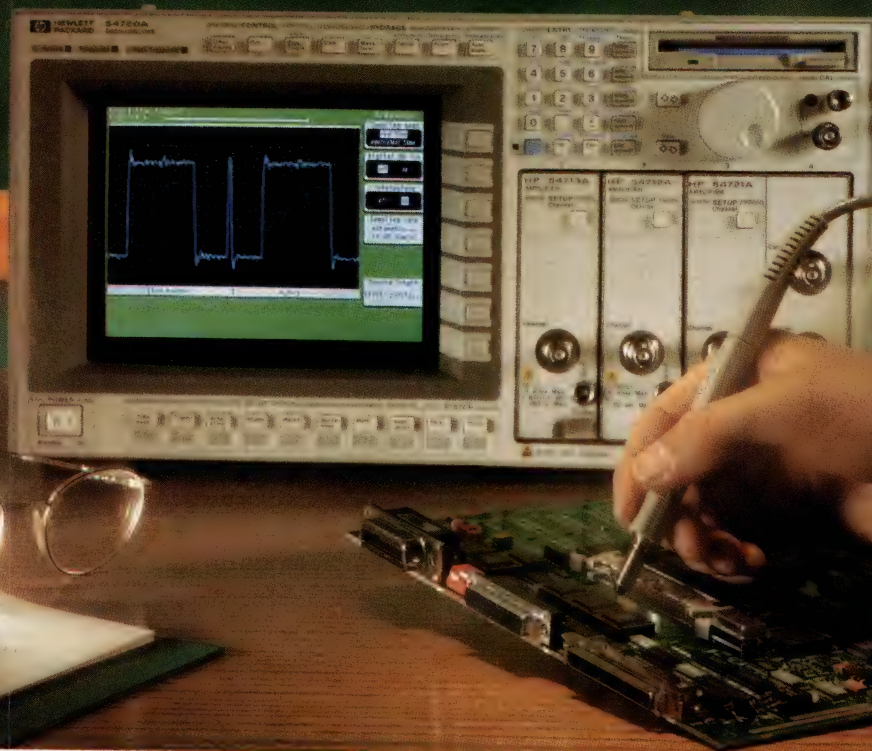
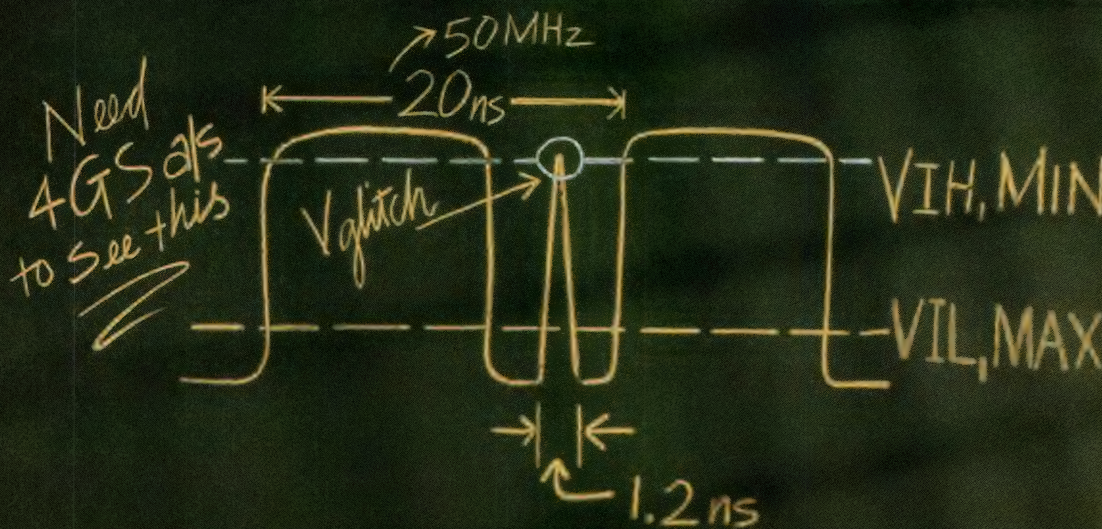


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CIRCLE NO. 39

EDN July 20, 1992 • 49

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Design products, not circuits



In the past, most electrical engineers could be content to work on their circuits or work with a team on circuit-related problems and technologies. If you're still working that way, you've got to change now. Today's designers can't be content to design circuits and remain disconnected from the overall problems and opportunities of product design. The days of the circuit designers are over. Today, you've got to be a product designer.

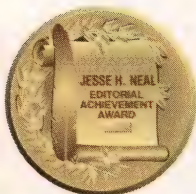
Yes, designing circuits, writing software, and developing test strategies will continue to be important. However, those activities have to be undertaken in the broad sense of product design. I'll bet that if you ask most engineers what they do, they'll tell you about the specific and narrow project they're working on. They won't say, "I design printers," or "I design communication equipment." Instead, they'll tell you they're working on a printer-controller board or a direct-digital synthesis down-converter board.

Engineers have to start thinking of themselves as product designers and they have to develop the skills that get them involved with almost all facets of product design. Given the CAD and CAE tools available, it's difficult for engineers to insulate themselves in niche-design areas. Engineers have to be involved as soon as marketing people and engineering managers start to define customer needs and outline ideas for products. Engineers have to be in on evaluating competitive product ideas,

prototyping ideas, and testing new approaches. Engineers have to be part of the manufacturing team and part of the group that tests and repairs products, too.

So what's the average engineer to do? First, start thinking of yourself as a product engineer and keep in mind that someone has to buy, use, and sometimes fix your product. You've got to design with the customer in mind. I remember trying to change configuration switches and jumpers on several computer mother boards. The jumpers and switches were located under the disk drives, so I had to disassemble most of the metal case first. Whoever designed the circuit board did a good job because the computers worked well. Unfortunately, the design team wasn't made up of product engineers. If it had been, the switches and jumpers would have been where you could get at them, and they would have had clear labels.

Also, today's tools give you a lot of flexibility to design top-down and bottom-up. Design tools are also moving engineers away from the implementation details of circuits and components. Sure, prototypes and Spice simulations are still important, but it's unnecessary to know what every gate in your PLD or ASIC actually does. Being able to let the tools perform their functions lets you back off from implementation details and take a look at the "big picture" of proper product design. The future belongs to the engineers who can do just that.



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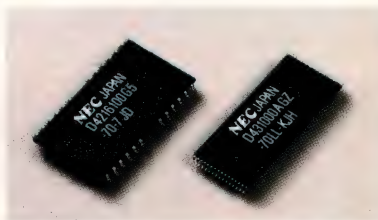
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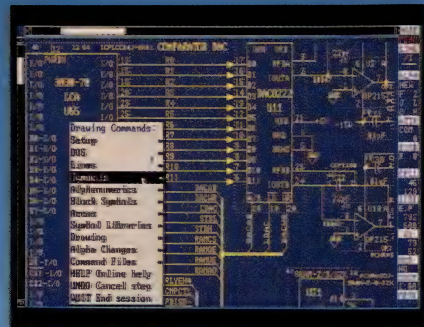
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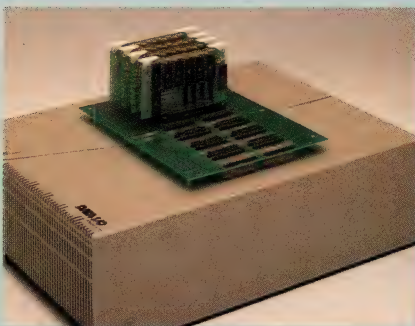
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ASIC for printer controllers enhances half-tone print quality

The half-tone-image quality that laser printers offer depends more on the half-tone algorithm used to render the image than the actual resolution of the printer. The D9010 printer-controller ASIC from Destiny uses "perceptual-layer" algorithms to produce photographic-quality images on standard 300-dpi printers. The IC also includes the company's edge-enhancement technology that produces smoother edges on text and line art.

You can use the ASIC with standard 300-dpi printer images and with the coming 600-dpi offerings. The ASIC operates independent of the page-description language, and can therefore be used in printers based on Postscript, Hewlett-Packard's PCL (printer-control-language), and GUI

(graphical-user-interface) imaging models. The IC can be used with any type of μ P.

Most available laser printers use a single-size binary dot to simulate half-tones. A collection of individual pixels makes up the half-tone dot. A darker image requires more of the pixels to be On than Off, and a lighter shade requires just the opposite. The human eye perceives the image as a continuous gray tone. Creating a gray image with a cell of On and Off pixels effectively reduces the resolution of the printer. A 2×2 -pixel half-tone cell can represent five gray levels, but it cuts resolution in half.

Introduced last year, the vendor's edge-enhancement technology improves the quality of text and line art by modulating the laser-beam

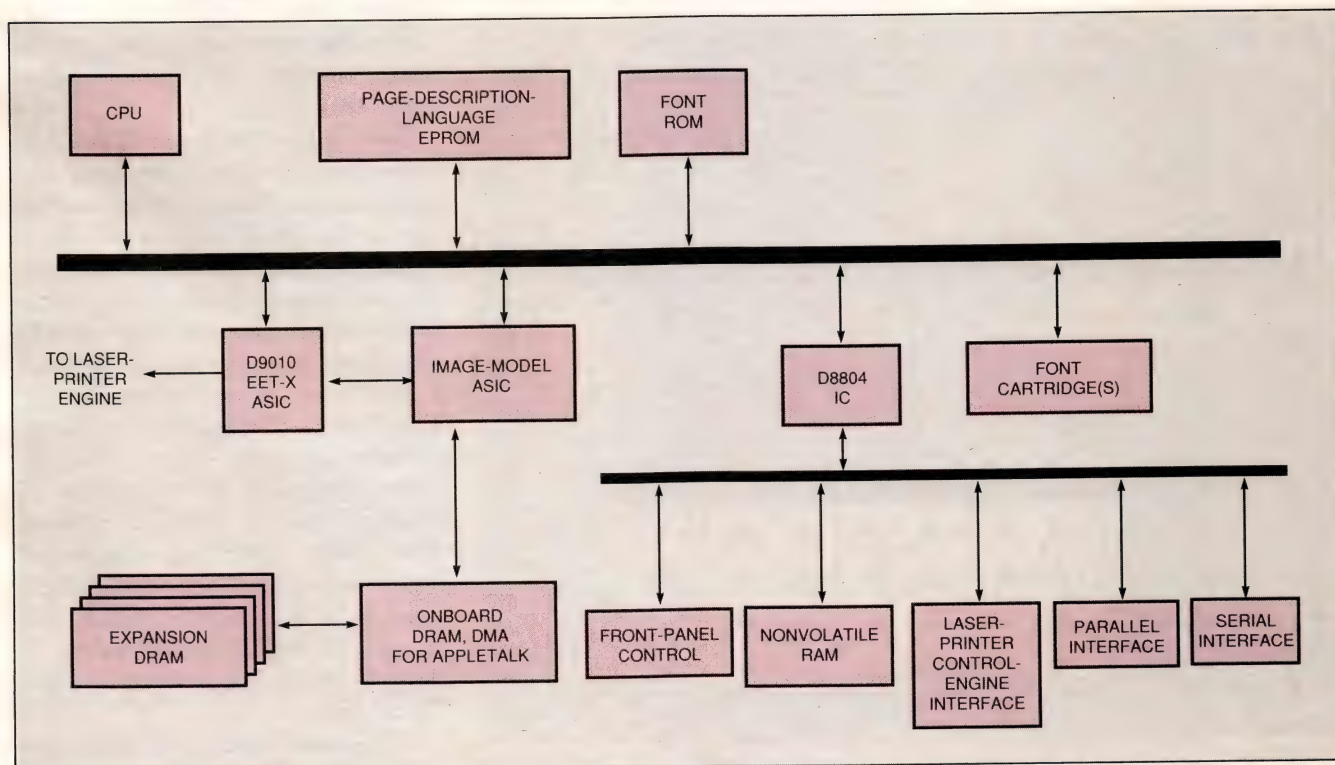
pulse to create different-size pixels. The EET-X technology in the D9010 uses the variable-size dots and optimized half-tone cell configurations and produces gray-scale images with the perceived quality of a 2400-dpi engine.

The ASIC implements the algorithms in hardwired logic, ensuring that printer performance isn't adversely affected. The 28-pin DIP costs \$35 for samples. Because the IC handles the rendering, designers can build D9010-based controllers with standard low-cost μ Ps rather than having to use RISC CPUs.

—EDN Staff

Destiny Technology Corp, 300 Montague Expressway, Suite 150, Milpitas, CA 95035. Phone (408) 262-9400. FAX (408) 262-0221.

Circle No. 744



The "perceptual-layer" algorithms used in the D9010 ASIC allow 300-dpi printers to produce half-tone images with the perceived quality of a 2400-dpi engine.

BiNMOS cell-based array provides high density and flexibility

Signetics' Hi-IQ cell-based array (CBA) delivers gate-array turnaround speeds and almost standard-cell densities. The increase in density is due to a new cell-based architecture—the ASIC is made up of blocks of sets of small logic transistors, supplemented by special drive transistors. This approach raises chip-logic densities, especially for SRAMs (static RAMs) and registers, because it uses smaller logic transistors.

The Hi-IQ (High Integration Qubic) array integrates Signetics' Qubic BiCMOS process with Siarc's (San Jose, CA) BiNMOS-CBA architecture. These arrays are the first commercial products to implement Siarc's channelless architecture. Siarc also provides cell libraries

and an SRAM compiler for the arrays.

Gate arrays started out as high-efficiency, low-cost alternatives to discrete board glue logic. High density now enables gate arrays to serve as major building blocks for both combinatorial and sequential logic, including main register banks. High-density, channelless, sea-of-gates gate arrays provide a vast area of transistor sets (two transistor pairs) ready for metallization. Unfortunately, these transistors must perform dual duty: They must form logic and drive loads in the array. This duality necessitates larger transistors.

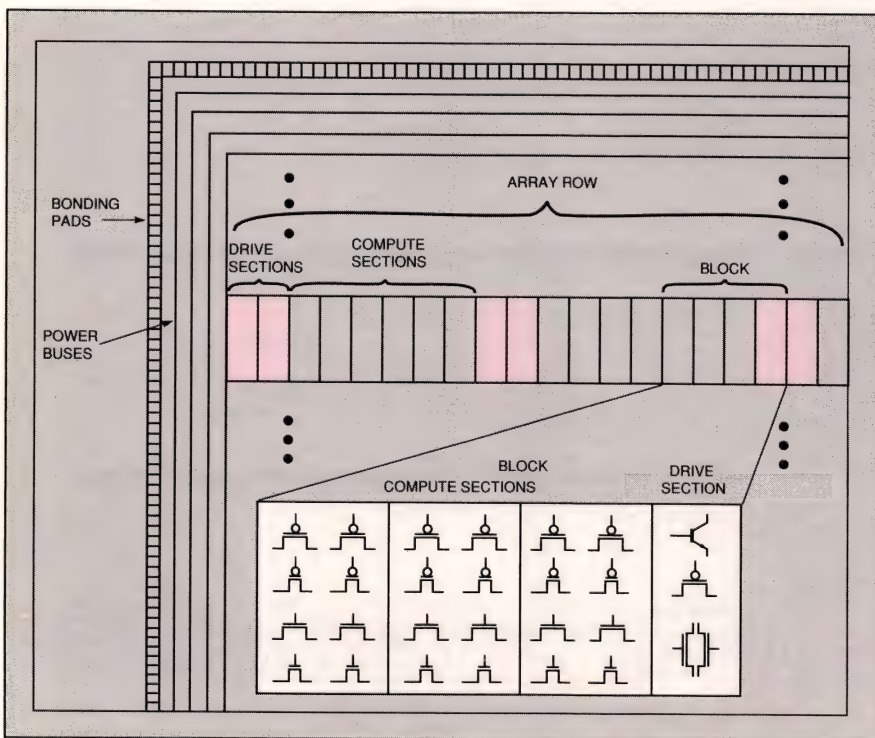
Channelless gate-array technology delivers high logic densities but is less efficient for SRAM and regis-

ter memories. Vendors such as LSI Logic (Milpitas, CA) neatly solved this problem by combining channelless gate arrays with high-density, SRAM standard cells. The CBA approach provides an alternative to mixing technology by deploying small, high-density logic/memory transistors that combine to produce high-density, on-chip memories. These transistors can be smaller because designers relieved them of the duty of driving signal nets.

The BiNMOS-CBA architecture goes a step further than the channelless sea-of-gates architecture: It partitions the chip into a channelless array of transistor blocks. Each block contains both drive and logic transistors, but only the drive transistors drive large signal nets. Thus, the logic transistors can be much smaller than typical gate-array transistors.

Each CBA transistor block has three compute sections and one drive section. The compute section has eight relatively small MOS transistors. The drive sections, on the other hand, contain a single npn pull-up transistor, two large NMOS pull-down transistors, and a small PMOS level-restoring transistor. Two layers of metallization interconnect the array transistors. Interconnects are not restricted to blocks; drive or logic transistors from other blocks can implement logic macro cells. Each compute section maps into approximately 1.7 equivalent usable CMOS gates. A flip-flop macro takes seven or eight CBA blocks.

CBA-based macro densities are higher than many current-generation CMOS sea-of-gates arrays. The CBA is designed so that a single



The Signetics BiNMOS-CBA is a channelless array of cells made up of logic and drive transistors. With local drive transistors, logic densities are higher due to smaller logic transistors.

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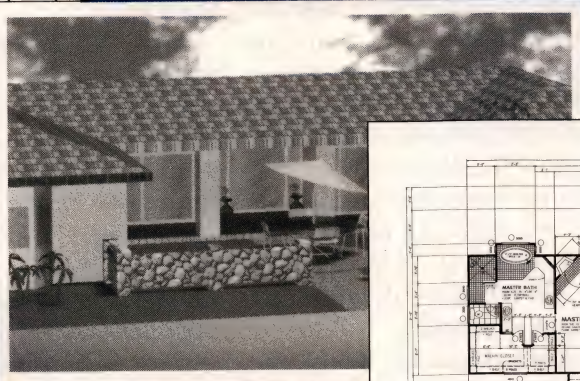


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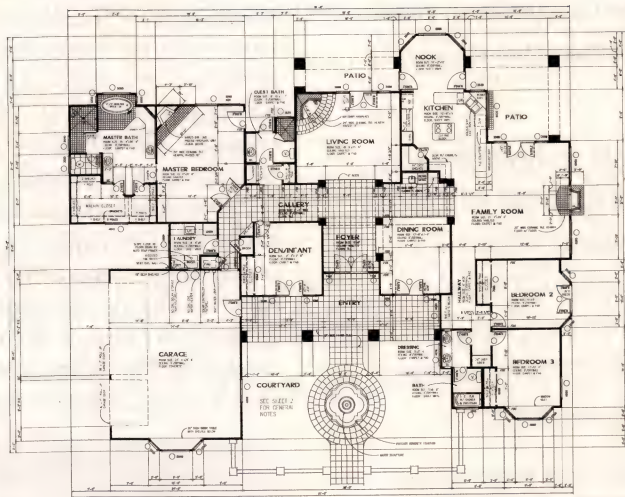
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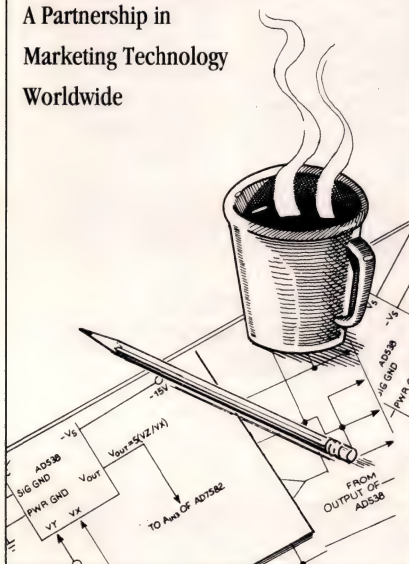
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compute section maps to one bit of single-ported SRAM. Signetics' comparisons show an overall density improvement of 128% over some CMOS sea-of-gates gate arrays.

New gate arrays, such as LSI Logic's 0.6- μ m LCA300K series, offer higher densities—as many as 500,000 usable gates having two or three levels of interconnect. Users can embed large blocks of standard cells, such as SRAMs, into these arrays. Signetics' approach relies on architectural innovations such as cell-based arrays, rather than increasing raw transistor densities, to provide higher density.

According to Signetics, Hi-IQ array utilization typically runs at 40% of available equivalent gates. This rate climbs as on-chip SRAM increases, hitting a theoretical 85% utilization for single-ported SRAMs. Users can generate single-ported

SRAMs using the Memory Compiler program. SRAMs can be up to 144 bits wide, you can place them anywhere in the array, and they have a power-down option to save power. A 1k \times 9-bit SRAM takes up 2.2 \times 2.9 mm and has a read cycle of 6.2 nsec.

Most BiCMOS arrays either have bipolar I/O or provide totem-pole BiCMOS drivers. The CBA BiNMOS replaces the CMOS P-channel output transistor with an npn bipolar transistor to speed up the critical CMOS low-to-high transition. It also adds a second N-channel device for high drive conditions (beyond 2.0 pF).

Thus, BiNMOS drivers are available for all macro cells. An inverter incurs a 230-psec (fanout=4) delay; and a 2-input NOR takes 300 psec (fanout=4). An inverting TTL input buffer takes 0.5 nsec (fanout=3), and a 24-mA TTL output driver (50 pF) takes up 2.5 nsec.

The CBA Macro library has more than 350 sequential and combinatorial macro cells. The library is EDIF 2.0.0 compatible and has Verilog simulation models. Many of these macros were built using Synopsys (Mountain View, CA) synthesis tools, which you can also use to synthesize logic for the Hi-IQ family. An EDA tool chain is available for the family, including an SRAM Compiler, Synopsys schematic-capture and synthesis tools, a Verilog simulator, and the Cadence (San Jose, CA) Gate Ensemble Place-and-Route and Delay Extractor. —Ray Weiss

Signetics Co, 811 E Arques Ave, Sunnyvale, CA 94088. Phone (408) 991-4019. FAX (408) 991-2311.

Circle No. 743

Signetics BiNMOS Cell-based array

- Channelless array of blocks—ordered sets of transistors having logic and drive sections
- Each block has 3 compute and 1 drive section
- Compute section has 8 small transistors for SRAM, logic
- Drive section has 4 drive transistors: 1 pull-up npn transistor, 2 large NMOS pull-up transistors, and a small PMOS level-restoring transistor
- Signetics Qubic BiCMOS-process 0.7- μ m channel length, 1.0- μ m polysilicon BiCMOS, npn F_T = 13 GHz
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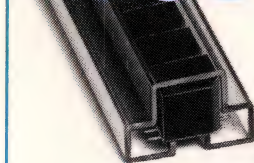


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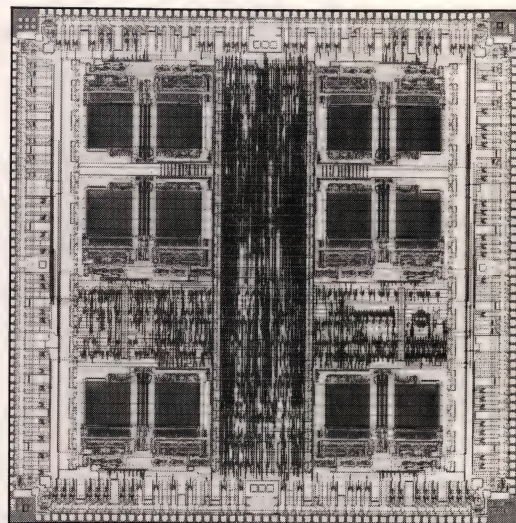
EDN-PRODUCT UPDATE

Analog/digital ECL ASICs exceed 1 GHz

This family of cell-based ECL ASICs combines analog functions, digital functions, cell-programmable power dissipation, toggle rates as fast as 2.5 GHz, gate delays of 70 psec, and relatively high packing density. One of the first four family members has six embedded 3-nsec static RAMs. The family comprises two series: Rise (RAM-intensive system elements) and Use (universal system elements). The initial ASICs in this family are described in the table.

The ASICs employ the company's Ocean of Cells technology. Each internal cell contains a handful of uncommitted resistors and npn transistors. Thus, a cell can operate either as a logic gate or as part of an analog circuit. The ASICs' I/O cells are more complex. They contain a mixture of resistors, capacitors, and transistors of varied size. The I/O cells can serve as ECL I/O, TTL I/O, or analog ports. Internal cells dissipate approximately 1 mW each, and I/O cells dissipate approximately 50 mW each.

As with all ASICs, pricing for this family is somewhat fluid and depends on which family member you pick and the packaging you want. At the low end, SY1BP00s packaged in 68-lead plastic leaded



This ECL ASIC comprises six blocks of 1k x 4-bit static RAM and cells that can perform either analog or digital functions.

chip carriers cost approximately \$18 (25,000/year). At the other end of the spectrum, SY9BP6R4s cost \$150 to \$300 (10,000/year) depending on the operating speed. NRE charges range from \$30,000 to \$150,000 depending on the part's complexity and the amount of work you require from the vendor. Toshiba America Electronic Components (Sunnyvale, CA, (408) 733-3223) serves as an alternate source for these ASICs.—**Steven H Leibson**

Synergy Semiconductor Corp,
3450 Central Expressway, Santa Clara, CA 95051. Phone (408) 730-1313. FAX (408) 737-0831.

Circle No. 742

Rise and Use series ECL ASICs

Device	Maximum number of gates	RAM block size	Number of RAM blocks	I/O pins
SY1BP00	1665	NA	NA	32
SY4BP00	9065	NA	NA	80
SY21BP00	33,555	NA	NA	144
SY9BP6R4	12,290	1k x 4 bits	6	144

Note: NA = Not applicable.



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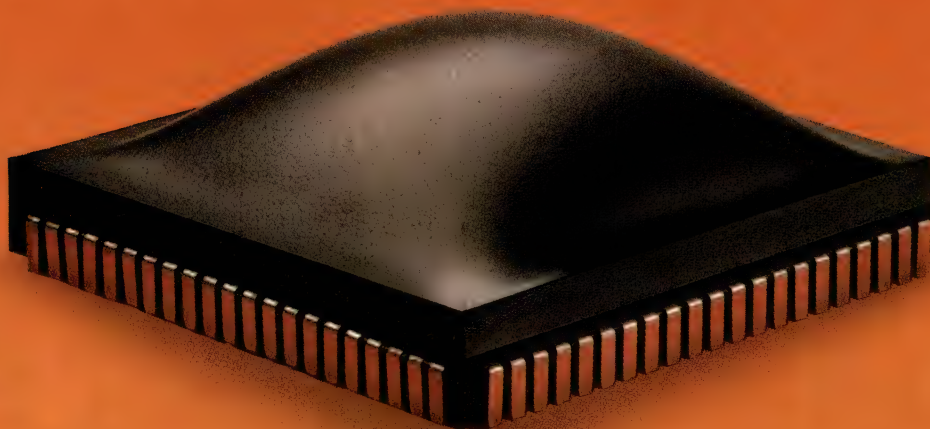
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Trimmed-down FPGAs fit in tight spaces and fit on PCMCIA cards

Cramming hardware into tight places is the name of the design game today. Small form factors like the PCMCIA (PC Memory Card International Association) standard memory, function cards, or 1.8-in.-disk drives demand small, surface-mount components. Many microcontrollers (μ Cs) and most programmable logic, for example, can't fit into PCMCIA I/O cards. To meet these card-space needs, Xilinx redesigned four of its RAM-based field-programmable gate arrays (FPGAs), trimming package size from 4.4 mm thick and an area of 8.59 cm² to a maximum thickness of 1.7 mm and an area of 1.96 cm². Lead pitch is 0.5 mm. These reworked chips can fit on PCMCIA cards, which resemble a 3.3-mm-thick credit card with a connector on one end.

Xilinx's X3000 FPGA family ranges in size from 2000 to 9000 raw equivalent gates. Three members of this family and one member of the early XC2000 family were repackaged in thin quad flatpack (TQFPs) or a small-outline-IC (SOIC) packages. All members of the X3000 family have 100 pins and measure 14×14×1.5 mm except the PROM, which measures 4.3×3.9×1.6 mm.

Engineers are already designing these small form-factor FPGAs into PCMCIA cards, using them for key glue and control logic. Using an FPGA rather than discrete or PLD logic, designers achieve higher densities. An additional feature of the Xilinx RAM-based FPGAs for PCMCIA design allows you to dynamically load them from the host PC system via the PCMCIA connector. Dynamic-load FPGAs provide several key benefits:

- Engineers can create a generic design and tailor it for specific application cards. One card

serves as a base for multiple card products.

- Designers can easily prototype and debug their logic. They can also correct errors without having to re-engineer the board or even remove the FPGA chip for reprogramming.
- Designs are dynamically modifiable; they can change as the PCMCIA design specification evolves. Barring large-scale changes, older products are upgradable to new PCMCIA specifications without a board redesign.
- The RAM-based FPGA dissipates lower power than other fuse or antifuse configurations.

For those designs that require on-card loading of the FPGA programs, the vendor provides a special low-profile, small-outline (SO) ROM that holds as much as 64 kbits of configuration data. Or, when the FPGA design is stable, users can opt for hard-wired or masked ROM parts, which do not have to be dynamically loaded.

The PC Memory Card International Association first met in June of 1989 to define a standard form and interface for memory cards that users could insert, initially for portable PCs. However, PCMCIA's latest version, Release 2.0, defines a

portable-computer bus architecture with memory pinouts, as well as I/O interfaces for LANs, modems, radio communications, and standard peripherals. It defines a standard 68-pin connector and interface, with 8 or 16 bits of data and a 64-kbyte address space. Many engineers expect PCMCIA I/O cards to emerge as the medium for adding peripherals to both portable and desktop PC systems. In effect, the PCMCIA bus will be the PC equivalent of Sun's SBus, a mezzanine bus for adding card-based peripherals.

Most FPGAs are built around a common logic-core element. These chips consist of an array of these elements surrounded by interconnection resources and I/O support. Logic designs are created by interconnecting these elements, which forms a complete circuit. Xilinx's FPGAs are built around a core CLB (configurable logic block), a small programmable element made up of gates and two flip-flops. The underlying static RAM defines the CLB logic interconnections. Each FPGA is "programmed" with a final circuit by serially loading the CLBs' defining RAM.—Ray Weiss

Xilinx Inc, 2100 Logic Dr, San Jose, CA 95124. Phone (408) 559-7778. FAX (408) 559-7114.

Circle No. 745

Table 1—Xilinx field-programmable gate arrays

	Density (gates)	Clock rates (MHz)	No. of I/Os	Price
XC2018	1800	25, 33	74	\$31 (sample)
XC3030	3000	25, 50	80	\$47 (sample)
XC3042	4200	25, 50	82	\$63 (sample)
XC1765S08C PROM	64k	—	—	\$6 (sample)
XC3330	3000	25, 50	80	\$8 to \$11 ¹
XC3342	4200	25, 50	82	\$10 to \$13 ¹

Note: 1. Hardwired devices, 10,000 to 25,000.

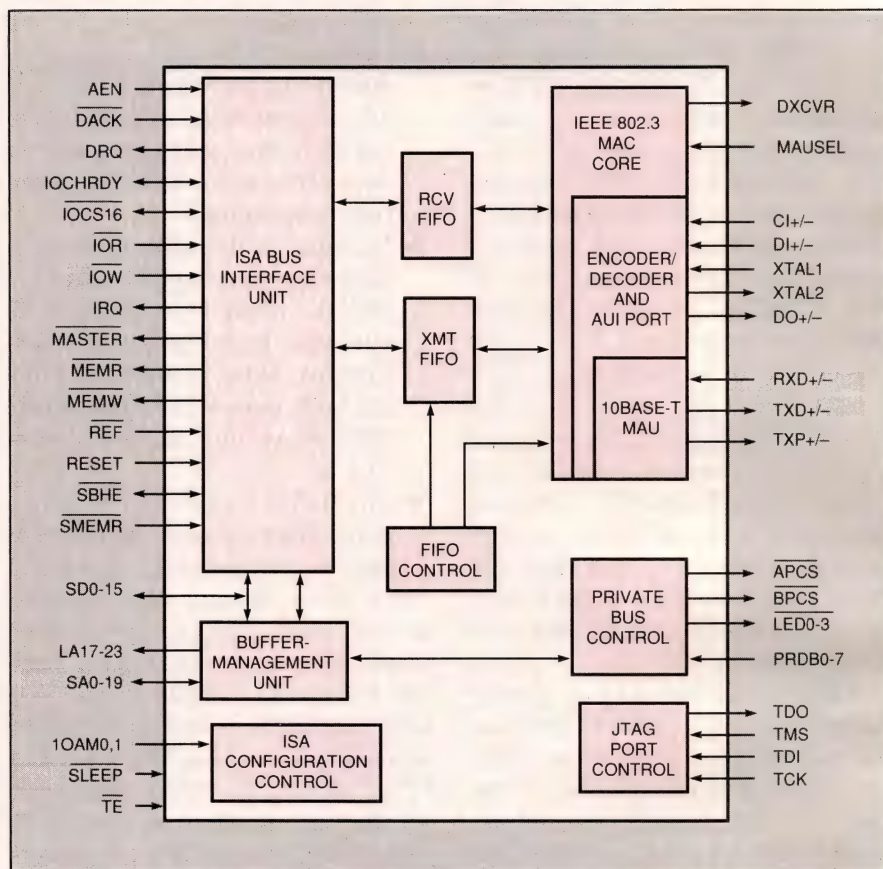
Low-cost Ethernet chip enables mother-board network controllers

The Am79C960 PCnet-ISA chip paves the way for embedding an Ethernet controller on an ISA bus mother board. Until now, if you wanted to connect your computer to an Ethernet network, you had to purchase an Ethernet adapter card for your computer's expansion bus. The low cost and high integration of the PCnet-ISA chip make it possible to integrate a complete Ethernet controller in a 2×2.5-in. area of the mother board.

The PCnet-ISA is a 120-pin VLSI plastic quad flatpack chip that supports the IEEE-802.3/ANSI 8802-3 Ethernet standard. The chip directly interfaces with a computer system's ISA bus. The Advanced Micro Devices chip contains an ISA bus interface unit, a DMA buffer management unit, an IEEE-802.3 media-access control unit, separate 136-byte transmit and 128-byte receive FIFO buffers, an IEEE-802.3 attachment unit interface (AUI), and a twisted-pair-transceiver media attachment unit.

The twisted-pair transceiver complies with the IEEE-802.3 10Base-T standard, including noise immunity and received-signal rejection criteria ("Smart Squelch"). The chip also automatically detects the receive signal's polarity on twisted-pair lines and corrects the polarity when the connection is reversed. Three port-selection modes let the chip automatically select the AUI or 10Base-T port or let you use software or jumpers to select the port yourself.

The chip is also register compatible with the company's Am7990 Lance controller chip. The DMA buffer-management unit supports the Lance descriptor software model. The chip's dual architecture



The highly integrated, low-cost PCnet-ISA chip enables manufacturers to integrate a complete Ethernet controller on an ISA bus mother board.

lets you configure the chip in two operating modes. In bus-master mode, the DMA controller performs transfers by bypassing the computer's DMA controller and directly addressing 24 bits of memory space. You can also configure the chip for shared-memory operations to be compatible with low-end PC/XT computers.

The chip employs 0.8-μm CMOS technology and operates from a 5V supply. The device has two sleep modes for portable-computer applications. Other features include a JTAG boundary-test access port; an integrated Manchester encoder/decoder; on-chip LED drivers for

transmit, receive, collision, receive polarity, link integrity, or jabber status; and an External Address Detection Interface (EADI) to allow external address filtering in internetwork applications. Internal and external loopback test features are also on chip.

The company provides software drivers for a wide range of network operating systems. Novell provides its own software drivers for the chip. A chip design on a mother board is fully compatible with Novell's NE2100 and 1500T Ethernet adapter cards. In addition, drivers are available for Microsoft's LAN Manager, Banyan's Vines, and Ar-

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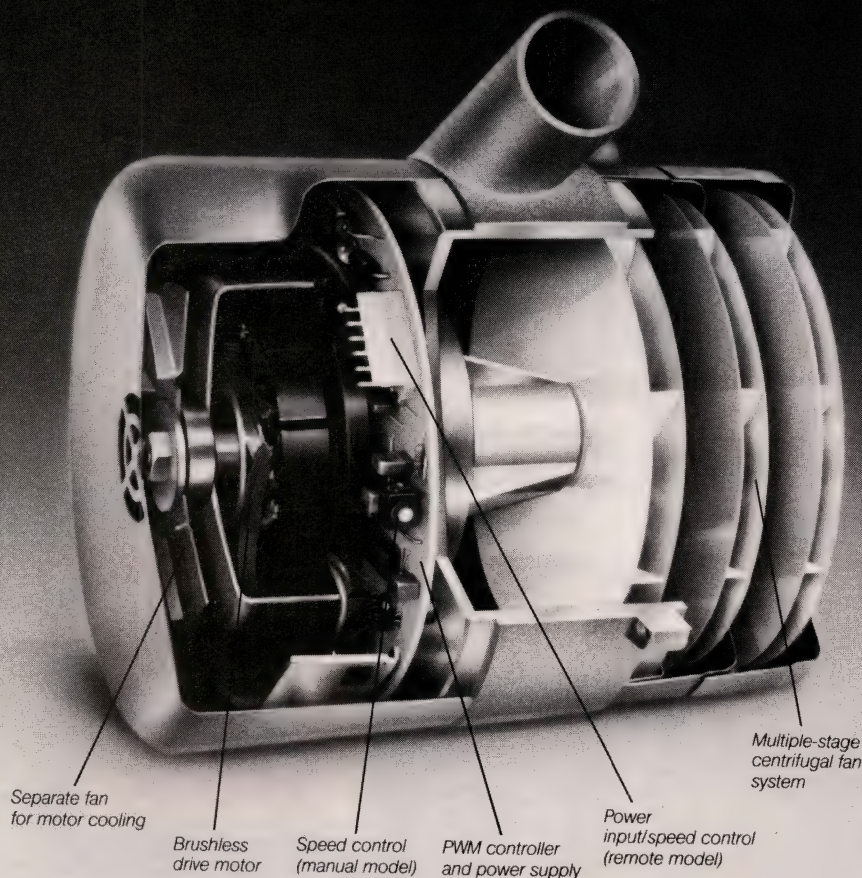
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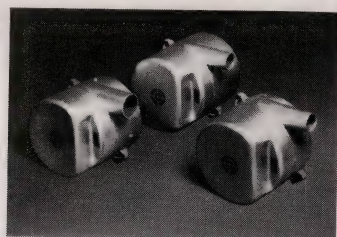
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CIRCLE NO. 48

EDN-PRODUCT UPDATE

tisoft's LANtastic network operating systems. Support for SCO's Unix is currently under development.

To build a complete Ethernet controller, you must add a few external parts. The controller requires an address PROM to store the node's physical Ethernet address and the board manufacturer's data. You also must supply a 20-MHz crystal, an RJ-45 twisted-pair connector, an AUI isolation transformer, status LEDs, and a handful of resistors and capacitors. The chip costs \$19.75 (10,000). At a \$5 estimated cost for the support circuitry, you can build a complete Ethernet controller on the mother board for less than \$25.

—John Gallant

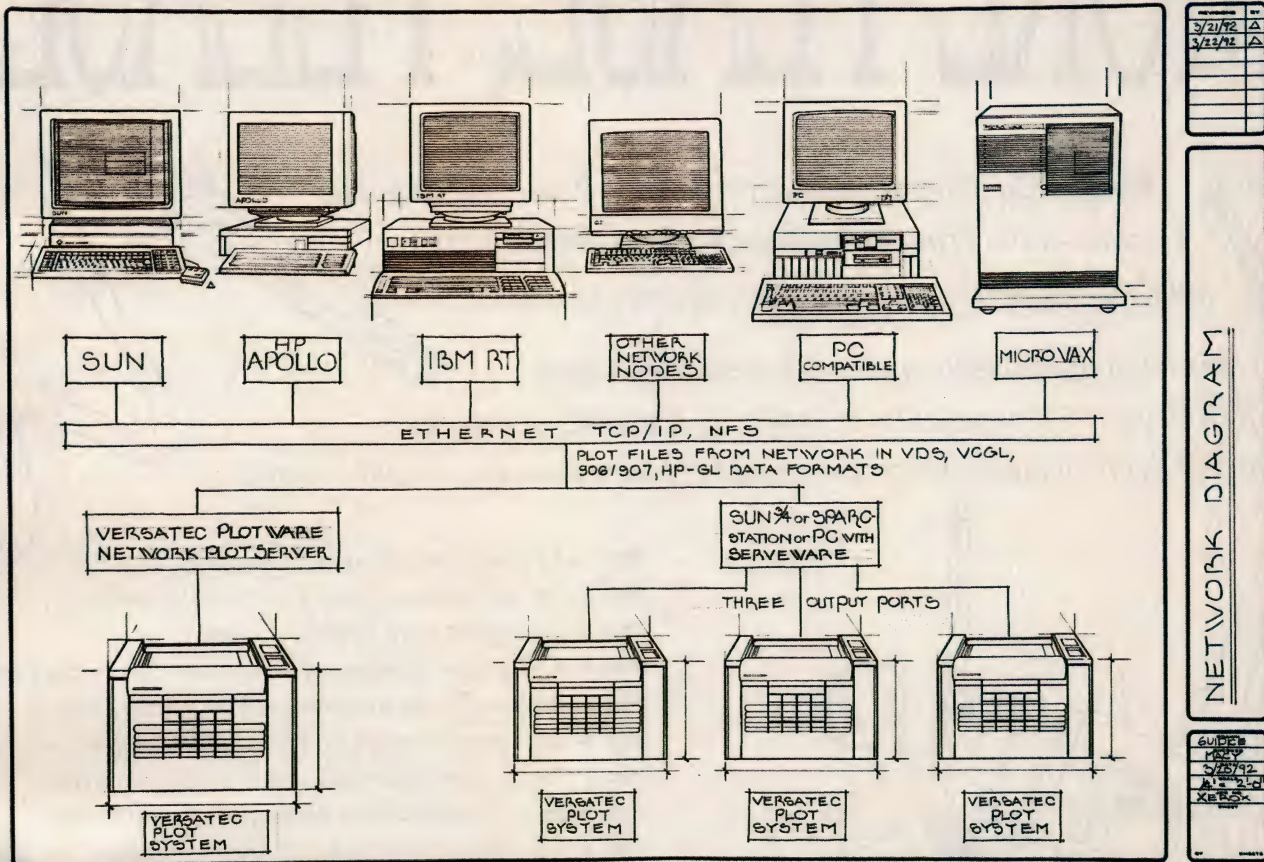
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MPEG video-decoder chips target low-cost applications

As MPEG (Moving Picture Experts Group) video ICs begin to appear, two are aiming at low-cost consumer products. C-Cube Microsystems and SGS-Thomson have introduced chips in the \$20 to \$50 range that will decode full-motion MPEG video in real time. The chips are suitable for CD video—perhaps the first MPEG mass market—and other applications, such as multimedia computing. C-Cube's CL450 is available now; SGS-Thomson's STI3240 will be ready in September.

The two chips perform most of the same functions. Both decode MPEG-compressed video; both yield YUV or RGB video in either NTSC or PAL (phase-alternation-line) format. Each requires external dynamic RAM (DRAM) and minimal support from a host μ P.

There are differences, however. C-Cube's CL450 (Fig 1) is an MPEG-only device, whereas SGS-Thomson's STI3240 (Fig 2) decompresses either MPEG or CCITT H.261 video. C-Cube's device includes an interface to a 68000-type μ P; SGS-Thomson's connects to either a Motorola- or Intel-type interface of 8 or 16 bits. The SGS-Thomson chip also requires an additional DCT (discrete cosine transform) IC that the C-Cube device does not.

The SGS IC decodes pictures of 352×288 pixels at rates as high as 30 frames/sec; C-Cube's chip decodes 352×288 pixels at 25 Hz or 352×240 pixels at 30 Hz. C-Cube's device operates on input bit streams with rates as high as 5 Mbps; SGS-Thomson claims 10-Mbps capability.

The SGS-Thomson chip costs less, although it is difficult to compare quoted prices for large quantities when companies don't define

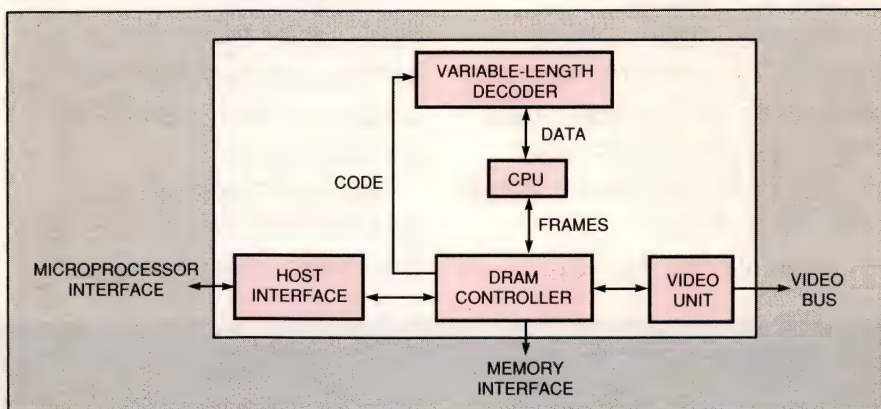


Fig 1—The CL450 MPEG decoder needs only a 4-Mbit DRAM and control by a 68000-type μ P to decompress video in real time.

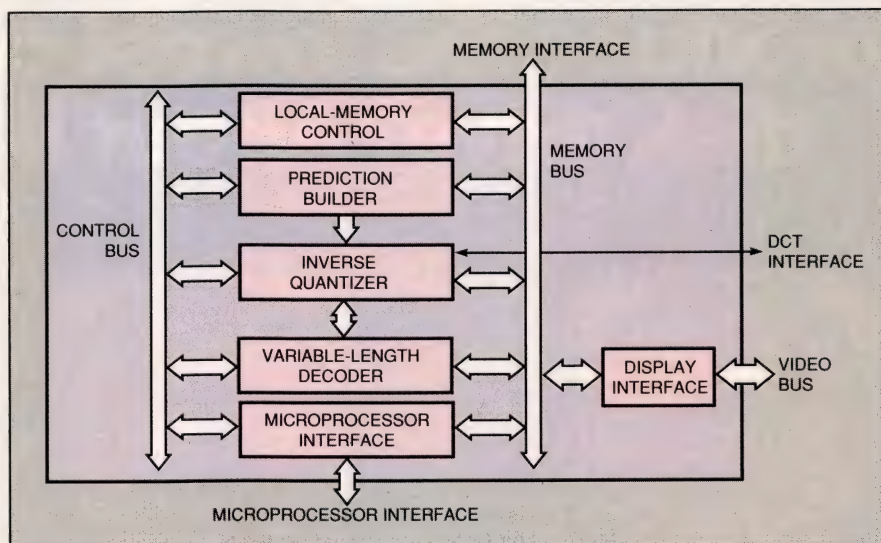


Fig 2—The STI3240 MPEG/H.261 decoder needs standard DRAM and a DCT processor to decompress video. A Motorola- or Intel-type μ P provides control via a standard 8- or 16-bit interface.

"large." C-Cube quotes a \$50 price for its CL450 in "consumer-electronics quantities"; samples are available for \$250. SGS-Thomson says its STI3240 is "projected to be in the \$20 range in volume"; the company hasn't stated a sample price. With the additional required DCT chip, SGS-Thomson expects the total cost of a decoder implementation to be about \$30.

—Gary Legg

C-Cube Microsystems, 1778 McCarthy Blvd, Milpitas, CA 95035. Phone (408) 944-6370. FAX (408) 944-6314. **Circle No. 433**

SGS-Thomson Microelectronics, Ave des Martyrs BP 217, 38019 Grenoble cedex, France. Phone (033) 7658 5184. FAX (033) 7658 5610. **Circle No. 434**

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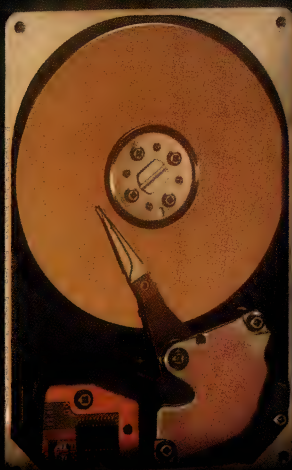
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Microcontroller integrates 8051 with CAN serial automotive bus

The popularity of rolling your own microcontroller (μ C) networks is beginning to taper off. Now, high-reliability network protocols provide a standard base for μ C-driven automotive and industrial-control systems. Standard protocols, such as the Controller Area Network (CAN) developed by Bosch, minimize development efforts and ensure compatibility for future products and components. Signetics/Philips integrated the 8051 μ C with the PCAB2C200 Philips CAN controller. The result, the 8xC592, is a single-chip μ C that provides an intelligent CAN network node.

The Controller Area Network is a serial, multimaster communications protocol; it supports distributed real-time control with a highly reliable network. CAN is built on a serial bus and operates at 125 kbps or 1 Mbps. A transceiver is used to link the 8xC592 to the CAN bus. A 16-MHz μ C drives data at rates to 1 Mbps. Semiconductor vendors supporting the CAN protocol include Intel, Motorola, National Semiconductor, and Siemens.

On the 8xC592 chip a DMA channel passes data between RAM and the CAN controller's Transmit Buffer or Receive Buffers. This

Controller Area Network

Originally specified by Bosch for automotive applications, CAN is a serial communications protocol. It is used in Europe but not in the US, where competing protocols include the SAE's J1850 and Chrysler's CCD. The protocol handles multiple processors, each of which can send and receive priority messages. CAN nodes request data by sending a Remote Frame message; the requested data is sent via a Data Frame with the same message ID. Messages are acknowledged by sending an ACK message.

CAN comes in two versions: a low-end version, basicCAN, with an 11-bit ID, and fullCAN, which has a 29-bit ID. Transmitted messages pass to all nodes on the bus (multicast), all of which take the message frame. The received messages are then filtered based on the message IDs. In basicCAN, the acceptance filter width is 8 bits, and for fullCAN it's 11 bits. In addition, fullCAN has controller memory for storing CAN messages.

CAN has only four message types: Data Frame, Remote Frame (requests data), Error Frame (signals a local node error), and an Overload Frame (extend delay before next frame). As CAN nodes place requests, the highest priority one takes the bus (priority is based on recessive vs dominant bits, where the dominant bits override the recessive bits).

CAN characteristics

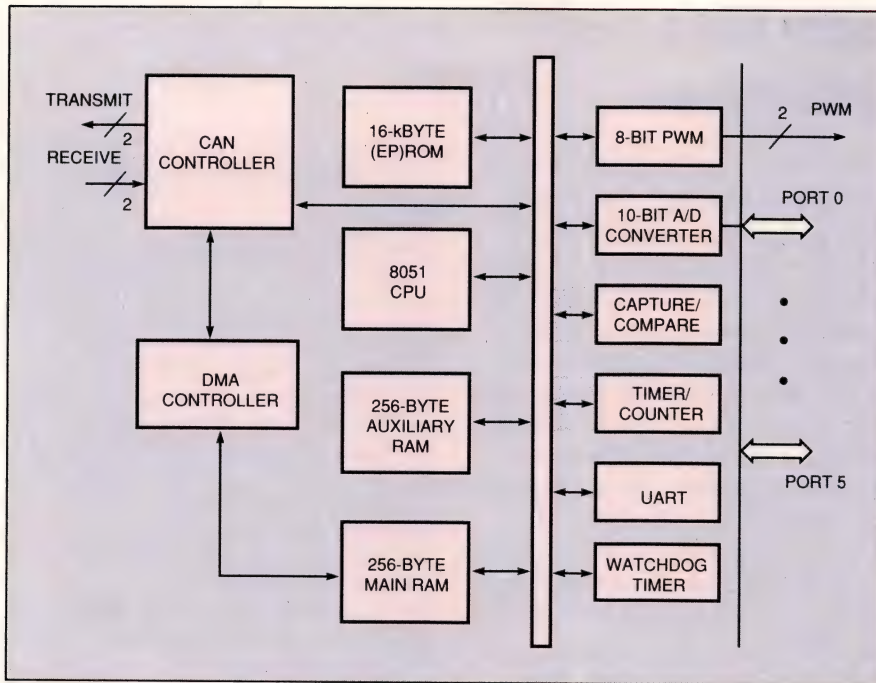
- Multimaster—multiple masters
- Priority-based transmissions: on message ID by node hardware
- All messages are received by all nodes; ID is the priority
- Message filtering: nodes filter messages using IDs before use
- 11- or 29-bit message ID
- Fixed message forms: variable length, to 8 bytes of data
- Built-in error detection and recovery
- Guaranteed latency for high-priority messages
- Low-power and radiation-noise implementations
- High reliability: CRC, message frame check, transmission monitoring
- Bit transmission to 1 Mbps
- Accommodates 100m between nodes (40m at 1 Mbps)

Signetics 8xC592 8-bit μ C

- 16-MHz external clock
- 80C51 CPU core: 12 clocks/basic instruction cycle, with multiple cycles for some op codes; 4 register banks in on-chip RAM; 8 8-bit registers/bank
- Program- and data-address spaces: 64 kbytes each—or 1 space combined
- CAN controller: DMA transfer between CAN registers to RAM; 4 special-function registers accessible by CPU; full CAN protocol
- 2 blocks of 256-byte RAM
- 16-kbyte program ROM/EPROM
- 2 16-bit timer/counters
- 16-bit timer/counter with 4 capture and 3 compare registers
- Watchdog timer
- 6 8-bit I/O ports
- 8-channel, 10-bit ADC
- 2 PWM outputs (8 bit)
- 15 interrupt sources; 3 external interrupts; 5 CAN interrupts
- Maximum interrupt-response time: 5 cycles (3.75 μ sec)
- Full-duplex-UART serial port
- Power modes: Active, Idle, Power Down, Reset; CAN has Idle mode
- -40 to +125°C
- 68-pin PLCC or ceramic leadless chip carrier
- One-time-programmable version, \$35 (100). ROM and ROMless versions will be available first quarter of 1993

DMA block move instruction runs in the background, behind CPU processing. It takes as many as two instruction cycles for each data transfer. Two Receive Buffers minimize CPU processing. CAN events generate interrupts to notify the CPU for CAN processing.

The 8xC592 runs with a 16-MHz clock. Its basic machine cycle takes up 12 clocks, with 1, 2, or 4 machine cycles per instruction. A basic instruction executes in one, 0.75- μ sec cycle. CAN processing loads down the CPU in proportion to the CAN bus load and bit transmission rate. For a 1-Mbps bit rate and a 50% bus load with a 4-byte message, the CPU's loading takes



The Signetics 8xC592 combines an 8051 with a Controller Area Network (CAN) for automotive and industrial control. Data passes between RAM and the CAN controller via a background DMA. The CAN controller sets interrupts to signal the CPU.

roughly 21% of available processor cycles.

An evaluation board is available with 32 kbytes of static RAM for RAM and 32 kbytes of EPROM for ROM. It has a wire-wrapped field for prototyping circuits. The board can be used directly in an automotive system, running from a 12V power line. An RS-232C interface

links to a terminal or host PC for debugging the 8xC592 running under control of a monitor in EPROM. In addition, an in-circuit emulator is also available from Signetics.

—Ray Weiss

Signetics Co, 811 E Arques Ave, Sunnyvale, CA 94088. Phone (408) 991-2000. FAX (408) 991-2311.

Circle No. 700

μP links PC bus to two serial channels

Today's PC is turning into a lean machine as engineers ruthlessly drive down chip counts. Zilog's Z80182 is a good bet to further minimize glue logic and other unnecessary logic. The processor serves as a link between two modem or fax communications channels and a host PC bus and requires no extra chips or logic.

The Z80182 is built around an updated static Z80 core and the Z80S180 μP. It processes communications data on the fly by passing

it to or from the host via the PC/XT or PC/AT bus. The chip includes a PC/XT and PC/AT bus interface that mimics National Semiconductor's 16550 interface chip and eliminates the need for bus-interface glue logic.

The processor integrates the Z80180 communications controller with the company's Z85230 ESCC (Enhanced Serial Communications Controller), a dual-channel multi-protocol controller. The ESCC handles both asynchronous and synchronous protocols including the HDLC (high-level data link control), SDLC (synchronous data-link control), and Bisync (binary syn-

chronous communication) protocols.

The ESCC incorporates a cyclic-redundancy-check generator and checker as well as an even/odd parity generator and checker and a programmable digital phase-locked-loop transmission clock. The ESCC handles serial data rates as fast as 5 Mbps. The Z80182's CPU works in conjunction with the ESCC and uses off-chip RAM to buffer data. The CPU also links the ESCC channels to the PC host's processor.

The Z80182's Z80 core runs with a 16- or 20-MHz internal clock. This speed is twice that of a standard Z80 and reduces the Z80 instruction-cycle time by an average of 20%. Zilog engineers built EMI suppression into the processor to cope with the higher clock rates. You can program output-pin power

Zilog Z80182 embedded μP

- 16-, 20-MHz clock; divide-by-1 internal clock; static CPU can run to dc
- Basic Z80S180 μP with Z80 core
- 158 instructions, including block moves and memory searches
- Add to register takes 9 cycles; NOP takes 6 cycles (300 nsec at 20 MHz)
- 2 register sets of eight 8-bit registers supplemented by four 16-bit registers: 2 index registers, stack pointer, and program counter
- 64-kbyte local address space; MMU extends space to 1 Mbyte; no on-chip memory
- 8-bit interface to PC/XT or PC/AT bus mimics National Semiconductor's 16550 bus-interface chip
- On-chip Z85230 Enhanced Serial Communications Controller has 2 duplex channels for synchronous or asynchronous protocols
- 2 DMA channels; clocked serial port; UART with baud generator
- Programmable wait-state generator
- Programmable low-EMI/power output
- Two 16-bit timer/counters
- 4 external interrupts
- 24 I/O pins
- On-chip clock oscillator/generator with idle and standby modes
- 100-pin QFP or VQFP (very small quad flatpack)
- Sampling now: \$13.99 for 16 MHz; \$16.79 (10,000) for 20 MHz



With Motorola's fuzzy logic educational kit, you can learn how to design systems using Motorola's standard 8-bit microcontrollers that perform better, get to market sooner, at far less cost. And if you're one of the 10 people to score the highest on the fuzzy logic test and project, we'll send you to Hawaii to learn more.

For only \$195, our kit* will provide computer-based training materials that will take you step-by-step through fuzzy logic fundamentals, practical application considerations, and a detailed example. You will receive a demonstration version of Apronix's Fuzzy Inference Development Environment (FIDE) software, an easy-to-follow PC-based tutorial, and other support software. Or if you need real-time evaluation, (not required for successful completion of the course) a limited



quantity of board-level evaluation modules (EVM) for Motorola's 8-bit microcontroller plus the

* The kit requires a minimum of a PC-AT™ class or compatible, with one floppy drive, a 40MB hard-drive, a VGA monitor, DOS™ 3.30 with Windows™ 3.0 (DOS 5.0 is recommended)

educational kit will be available for \$600.

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Simply complete and return the test and the fuzzy logic software

project included in the educational kit. The 10 people who score the highest on the test and the project will win a trip to Hawaii this winter for a 3-day seminar on Fuzzy Logic led by the experts in the field. Tests and projects must be postmarked by October 17, 1992.



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To order Motorola's Fuzzy Logic Kit and the details on the Hawaii Fuzzy Logic Seminar Contest, fill out the coupon and mail it and your payment - payable to Motorola (company checks, money orders and cashier's checks accepted) to: Fuzzy Logic Kit, Motorola, Inc, PO Box 1466, Austin, TX 78767. Kits are also available through your local Motorola Sales Office or a participating Motorola authorized distributor.



Offer expires August 31, 1992

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- ☐ FLEDKT11* (Educational Kit with M68HC11EVM that emulates 68HC11 A-Series, D-Series & E-Series) - Price \$600
- ☐ FLEDKT00 (Educational Kit without EVM) - Price \$195 (\$295 after August 31, 1992)

☐ Send me more information about the special introductory version of the Motorola fuzzy logic development kit.

*Limited Quantity

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Title _____

Company _____

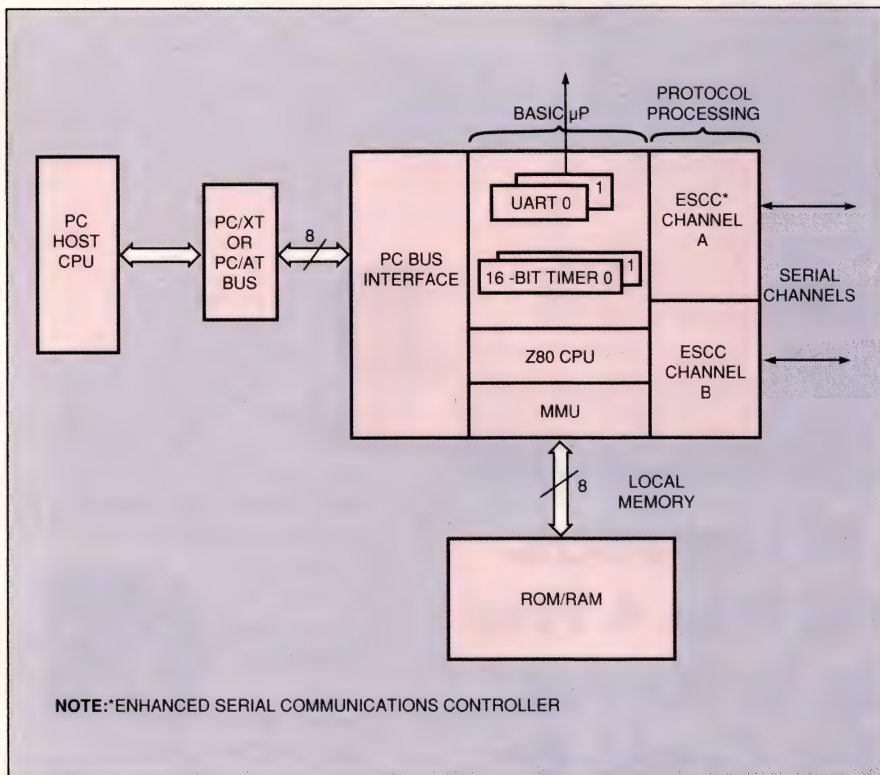
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Zilog's Z80182 combines an updated Z80 core with two serial communications channels and a PC/XT and PC/AT bus interface. This approach minimizes modem processing and glue logic for PC communications.

levels to reduce EMI by 75%.

The chip provides four levels of power management: run, sleep, system-stop, and standby modes. In sleep mode, the CPU stops, but on-chip I/O continues to run. In system-stop mode, both the CPU and the peripherals stop. In standby mode, the clock, internal clock, and external oscillators stop as well. Maximum current at 20 MHz for the normal, system-stop, and idle modes is 150, 25, and 12 mA, respectively.

Development tools, including C compilers and assemblers, are available. An evaluation board is available as well. The board uses a bond-out chip that separates the on-chip peripherals from the CPU. This enables an in-circuit emulator to replace the chip's CPU but still use the chip's peripherals.—**Ray Weiss**
Zilog Inc, 210 Hacienda Ave, Campbell, CA 95008. Phone (408) 370-8092. FAX (408) 370-8092.

Circle No. 701

High-speed next-generation 8051 runs at 3V

Some engineers swear at the 8051, but many designers swear by it. One of the first mainstream 8-bit microcontrollers (μ Cs), the 8051 fields a powerful instruction set and peripherals but has some first-generation implementation

limits. Oki Semiconductor took the 8051 ISA architecture, cleaned it up, extended it, and produced a fast 8-bit- μ C line, the MSM655xx. This series now comes in low-power versions, with a power-supply range of 2.7 to 5.5V ($\pm 10\%$).

The MSM655xx μ Cs are built around an optimized 8-bit core, the nX-8/51. Similar to the 8051, the nX-8/51 architecture is accumulator

based; external references to off-chip (general) memory go through the A-register accumulator.

Running at 10 MHz, the basic nX-8/51 instruction cycle takes 400 nsec, which is faster than the original 8051's 1- μ sec speed at 12 MHz. Other 8051s, such as Siemens' 80C501, run with a clock rate to 40 MHz. On the plus side, the nX-8/51 core delivers performance that's equivalent to higher clock rates while running at 10 MHz/sec. On the down side, nX-8/51-based μ Cs are not code compatible with existing 8051/52 code. However, translation software can translate 8051 code into nX-8/51 code, which is ready for hand optimization.

The nX-8/51 is a hybrid architect-

Oki MSM65514 8-bit μ C

- 10-MHz external/internal clock (runs to dc, static design)
- 4 clocks = machine cycle; instructions run from 1 to 9 cycles
- 400-nsec minimum instruction time; Register-to-A (R-A) Load takes 1 cycle, and an R-A Add takes 2 cycles
- 83 instructions
- 4 banks of 16 8-bit registers held in local RAM; 2 operation registers, A and B
- 8-kbyte ROM (one-time-programmable (OTP) version available)
- 384-byte RAM
- MPY/DIV unit with 6 registers: MPY = 4 cycles; DIV = 8 cycles
- 64-kbyte unified external address space, with external 8-bit bus; takes 1 basic machine cycle for each off-chip memory access
- 3 8-bit timers; 2 16-bit timers
- 14-bit time base counter; 3-bit watchdog timer runs from bit 13
- 1 capture and 2 compare 16-bit registers
- 8-channel, 8-bit ADC
- 1 UART with baud rate generator
- 3 external and 15 internal interrupts
- 2.7 to 5.5V ($\pm 10\%$) range (run at 4 MHz at 3V)
- Maximum power dissipation is 400 mW
- 4 8-bit I/O ports
- 64-pin plastic shrink DIP or PQFP; 68-pin PLCC
- \$3.80 (\$7.80 for OTP version) (10,000)

Marilyn, You're The Greatest.

If you asked Marilyn Monroe's fan club who they thought was the greatest screen actress, guess what they would answer. Fans express loyalty above objectivity.

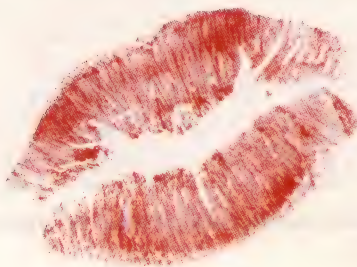
The same is true in publication readership studies. When a publication sends readership questionnaires to its own readers and asks, "Which publication do you read regularly?"—guess what they'll answer! While these studies are not wrong or misconducted, they result in an obvious bias.

If you're interested in a publication's readership, the best readership studies are conducted across a company's customer/prospect list or an *independent* industry list.

The next time you see a publication tooting its horn over a readership win at a company like IBM, AT&T, or Sun Microsystems—don't be too impressed. With those big-name headlines comes some small print. Take a second to notice where the questionnaires were sent. If it's a publication's own subscriber list then you'll know the study results are nothing more than fan mail.

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ture; it's basically an 8-bit machine with some 16-bit operations. The register banks and external bus are oriented toward 8-bit instructions and data words. However, the CPU has an 8-/16-bit ALU and a 16-bit temporary register (A concatenated with B) and 16-bit data instructions that include 16-bit Increment/Decrement, compare, data clear, data complement, and data move. Word-oriented instructions generally take multiple cycles because of an internal 8-bit data bus.

The nX-8/51 implementation evolves from the 8051 architecture. However, some structures and operations were altered, which allows less confining operation. The nX-8/51's instructions take an extra instruction cycle for each external memory access.

The MSM655xx family of μ Cs supports 8 to 32 kbytes of on-chip ROM. ROMless and one-time-programmable versions are available for development and prototyping. The chips maintain two address spaces: one is a unified 64-kbyte general-memory space with ROM and on-chip RAM; the other is a local RAM-based memory space,

which holds the data stack register sets and special-function registers (SFRs).

A number of useful instructions of this chip include

- DLY: programmable code execution delay multiple (not operations (NOPs))
- CALZ/C: call subroutine if zero or carry flag is set
- CMP, CMPW: compare bytes or words
- VCAL/Z/C: vector call (jump indirect with vector); also if zero or carry flag is set
- RT/Z/C: return from subroutine; also return if zero or carry flag is set
- MOVW: 16-bit data move
- SWAP: swap upper and lower data nibbles.

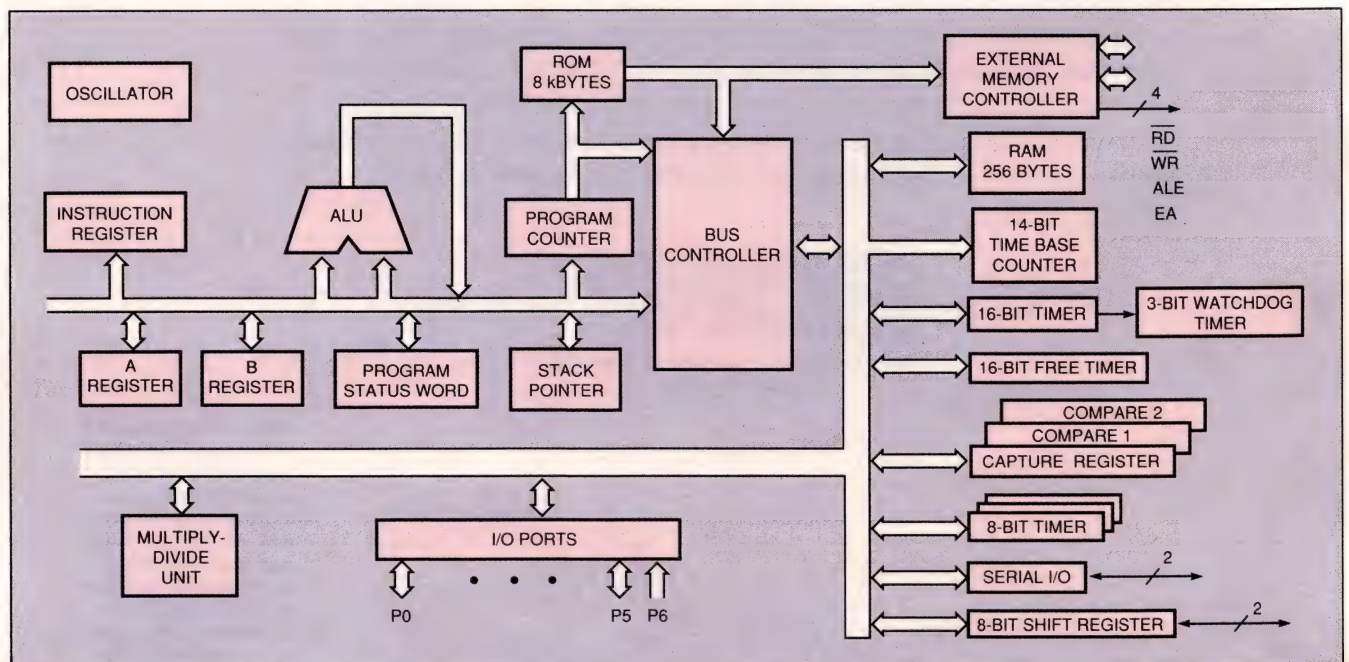
Limited master-slave multiprocessing is built into the MSM65xx μ Cs. Using a serial port, you can create a system with a single-master and multiple-slave μ Cs. Data transmission is only from master to slave via a serial bus. Slave-to-master communications must be hardwired-in using individual μ C ports.

The nX-8/51 8-bit core is ex-

tended to a 16-bit internal architecture, the nX-16/51, for the MSM66xxx μ C family. However, these μ Cs still keep an 8-bit external memory interface. The MSM67xxx, another nX-16/51-based family, combines the full 16-bit architecture with a 16-bit external bus and a faster core. The MSM67xxx μ Cs have a basic instruction cycle of 200 nsec, which is half that of other nX families.

A set of development software is available for the series. This set includes a relocatable assembler, a linker, 65K library, and an object-code converter that converts an absolute object file to an Intel Hex file for programming a μ C or external EPROM. A 65K Translator translates 8051 code to 65K code. Also, a 24-hour bulletin-board service disseminates software and uploads ROM code for manufacturing. The BBS phone number in California is (408) 736-5944 (8 bits, 1 stop bit, 2400 baud, full duplex ANSI or VT100/52 terminal emulation).—Ray Weiss

Oki Semiconductor, 785 N Mary Ave, Sunnyvale, CA 94086. Phone (408) 720-8940. **Circle No. 702**

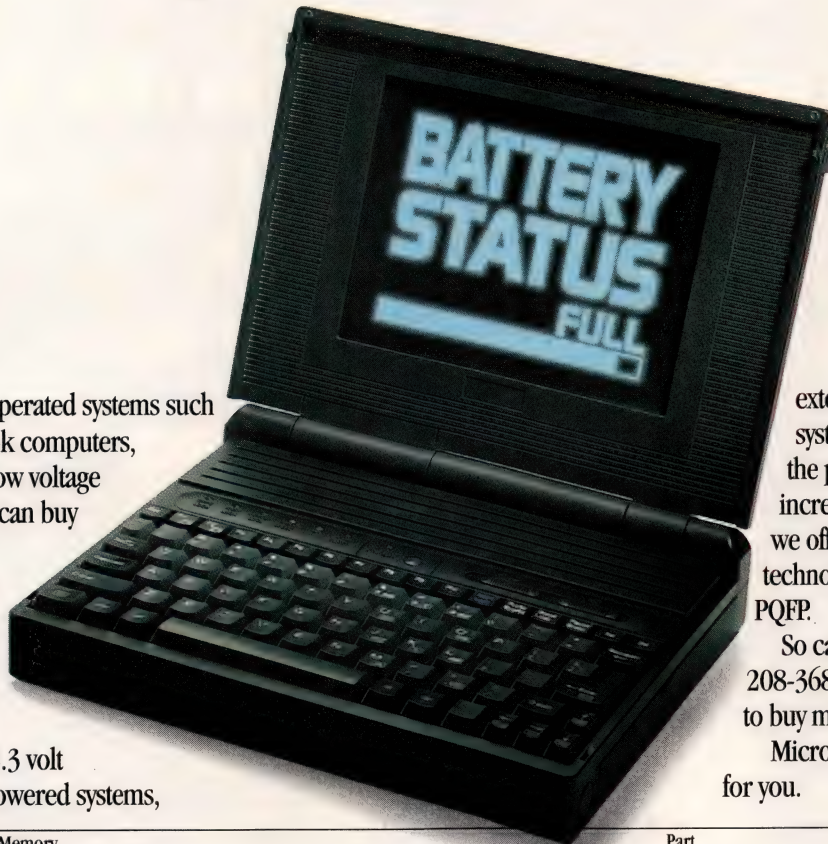


Oki's nX-8/51 μ C is based on a faster, redesigned 8051 core. Its basic machine cycle of 400 nsec at 10 MHz is faster than the 8051's basic 1- μ sec cycle at 12 MHz.

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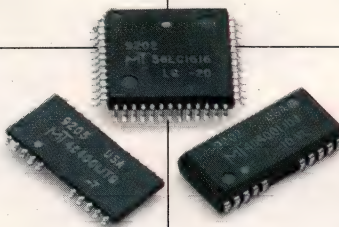


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MT4LC4001 S*	1 Meg x 4	4Q92	MT58LC1618 Synchronous	16K x 18	Now
MT4LC4001 L	1 Meg x 4	4Q92	MT5LC2516 Latched	16K x 16	Now
MT4C4256 VL	256K x 4	Now	MT58LC1616 Synchronous	16K x 16	Now
5 Volt, Low Power, Extended Refresh DRAMs			5 Volt, Low Power, Low Voltage Data Retention SRAMs		
MT4C1004J L	4 Meg x 1	Now	MT5C1001 LP	1 Meg x 1	Now
MT4C4001J L	1 Meg x 4	Now	MT5C1005 LP	256K x 4	Now
MT4C8512 L	512K x 8	3Q92	MT5C1008 LP	128K x 8	Now
MT4C16256 L	256K x 16 DW ¹	3Q92	MT5C2561 LP	256K x 1	Now
MT4C16257 L	256K x 16 DC ²	3Q92	MT5C2564 LP	64K x 4	Now
MT4C1024 L	1 Meg x 1	Now	MT5C2565 LP	64K x 4 OE ⁵	Now
MT4C4256 L	256K x 4	Now	MT5C2568 LP	32K x 8	Now
MT4C1664 L	64K x 16 FPM ³	Now			
MT4C1670 L	64K x 16 SC ⁴	Now			



*Self Refresh

¹DW— Dual Write Enable

²DC— Dual CAS

³FPM— Fast Page Mode

⁴SC— Static Column

⁵OE— Output Enable

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CIRCLE NO. 54

EDN July 20, 1992 • 81

**WHO'S GOT THE POWER
TO KEEP NEW GENERATION
DISC DRIVES
RIGHT ON TRACK?**



SGS-THOMSON Microelectronics

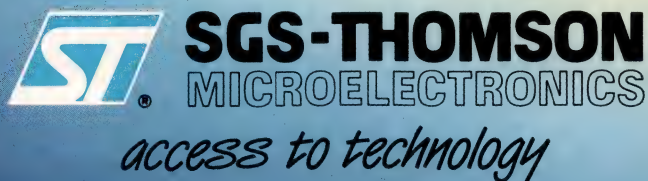
The Brighter Power

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CIRCLE NO. 58

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C O M P O N E N T S

ELEGANT ARCHITECTURES YIELD PRECISION RESISTORS

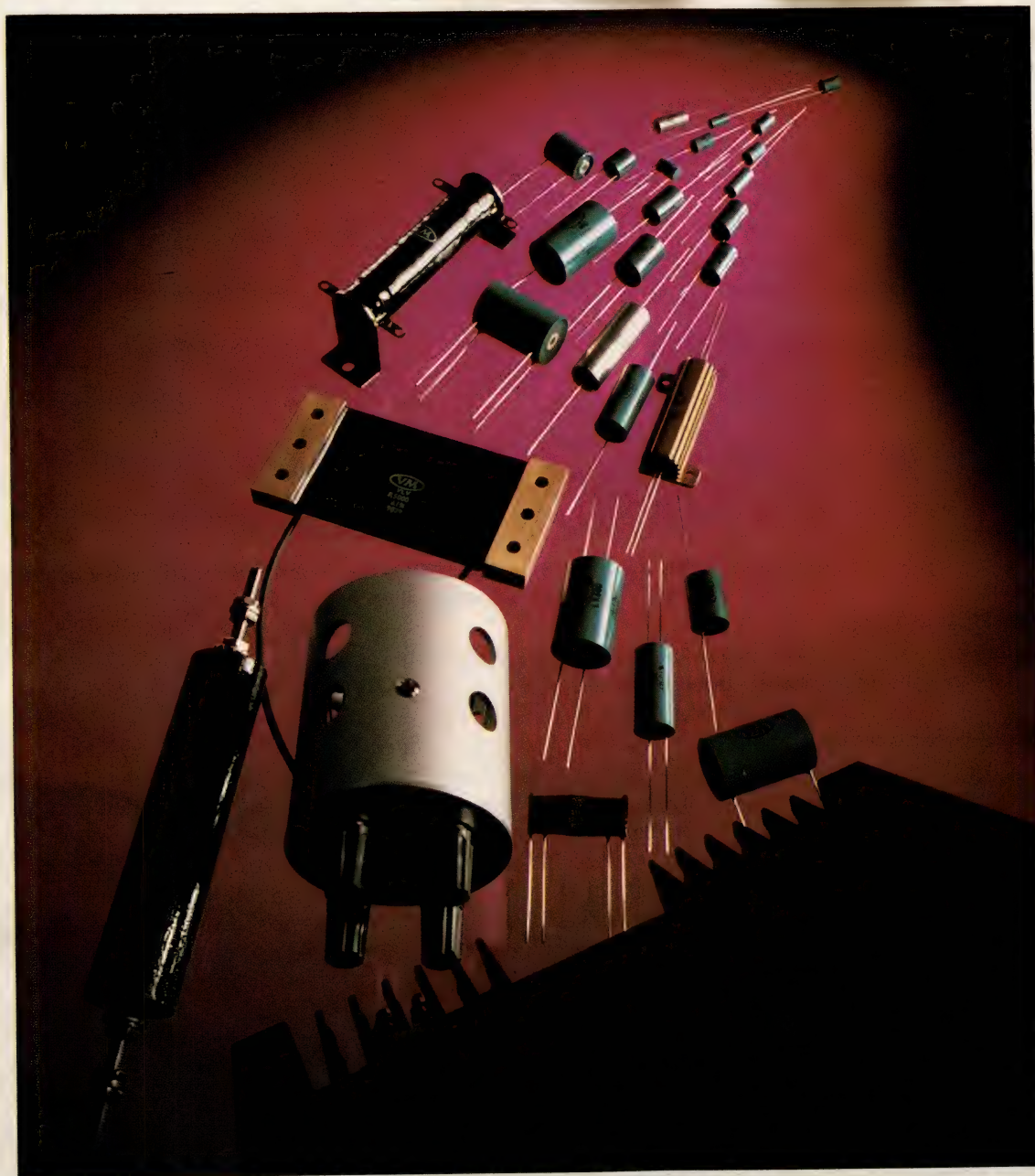
BRIAN KERRIDGE, Technical Editor

Three precision-resistor technologies produce TCRs of less than 10 ppm/°C. Intimate knowledge of these resistors' constructions will help you understand and predict how each type will perform in your circuit.

MENTION PRECISION RESISTOR, AND most designers will assume you're talking about some sort of wirewound component. It's true that selected-resistance wire still provides a good basis for the construction of stable resistors, but other technologies using foil and thin film produce resistors with similar or even greater stability.

Foil and thin-film technologies also overcome significant design drawbacks associated with a wirewound construction. Foil and thin film are ideal for resistance networks and also make it possible to combine precision with surface-mount-technology packaging. Foil resistors, with inherently low inductance and capacitance, form vital components for designing accurate ac RF-measurement circuits.

For ultimate precision, both foil and wirewound devices achieve temperature coefficients of resis-



tance (TCRs) of less than 1 ppm/°C, compared with 10-ppm/°C TCR for thin film. There's little difference between foil and wirewound performance for a dc design, and even price hardly distinguishes one from the other for values below 50 kΩ. A 1-kΩ, 0.1%, 5-ppm/°C TCR device costs approximately \$2.50 (100) in either foil or wirewound.

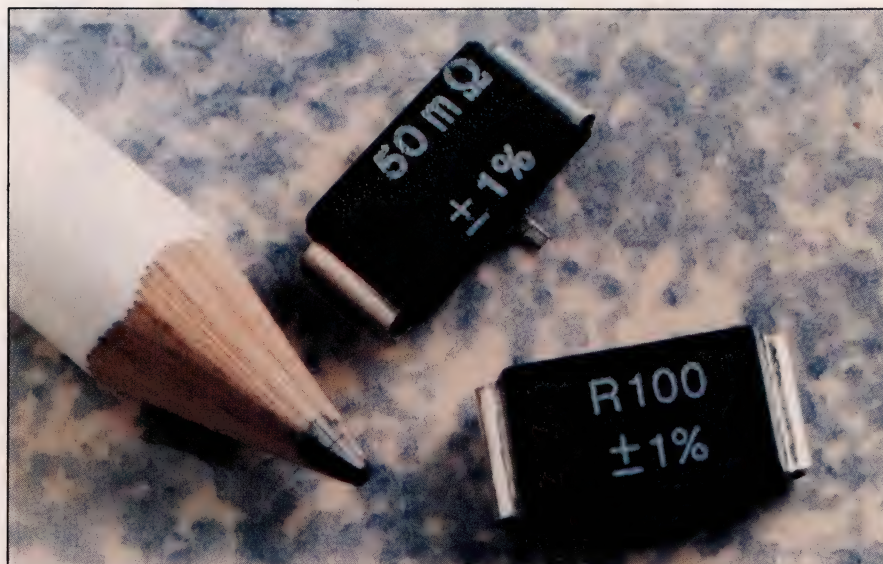
Precision wirewound resistors from Vishay Components suit high-power, metrology, or low-frequency accurate signal-conditioning applications.

Above 50 k Ω , wirewound types cost progressively less than foil—by as much as 30%. Foil-technology packages maintain a reasonable size only up to 250 k Ω . Above this value, and up to 1 M Ω , wirewound becomes a natural choice. Wirewound resistors also remain the only type to combine precision with high power rating (to 1 kW).

Thin-film-technology parts become particularly attractive above 1 M Ω , but if your design can make use of a resistor network, then thin film offers a low-cost route to precision at any resistance value—approximately \$1 per resistance element per network (100).

Defining precision

In today's terms, a TCR of less than 10 ppm/ $^{\circ}\text{C}$ qualifies a resistor as precision. Precision generally relates to a resistor's absolute TCR rather than its absolute-resistance tolerance at manufacture. Calibration of measuring circuits, particularly using digital correction techniques, obviates the need for resistors with very tight absolute accuracy in those circuits. Once calibrated however, the same circuits rely almost solely on the stability



Foil resistors from Isabellenhütte include SMT 4-wire versions in values as low as 10 m Ω . Using "Zeranin" foil, these components attain 5-ppm/ $^{\circ}\text{C}$ TCR.

of the precision resistors for maintaining circuit accuracy. In consequence, a designer's focus centers on in-circuit resistance instability effects, of which TCR is the major factor. In many designs, TCR tracking in gain-defining resistor pairs and networks contributes a valuable bonus to overall circuit stability.

Precision also relates to the magnitude of a range of secondary effects that can plague sensitive ana-

log designs. Effects of thermal-EMF generation due to self-heating or ambient-temperature gradients; long-term instability; and resistance stress from applied voltage, humidity, packaging, and soldering in at manufacture can all throw circuit-design performance off target.

Table 1 summarizes broad specification differences between foil, wirewound, and thin-film precision resistors, and, for completeness, mentions other and lower-precision types. You can find further coverage in Refs 1, 2, and 3.

The trend towards tighter stability tolerances follows the ever-increasing demand for more-accurate measurements—0.5-ppm (6½-digit) resolution is a common requirement in many test laboratories. Precision resistors are essential to the design of measurement circuits that can reach this level of accuracy and beyond. For many circuits, the magnitude of any drift in principal resistors shows up as an equally deleterious shift in output signals or instrument displays. Reference-voltage-level shifting, gain-defining amplifiers, and ADC/DACs are all applications that rely heavily on stable resistance components.

Just as digital designers swoon

Table 1—Characteristics of precision and other resistor types¹

Type	Absolute temperature coefficient ($\pm\text{ppm}/^{\circ}\text{C}^2$)	Tracking temperature coefficient ($\pm\text{ppm}/^{\circ}\text{C}^2$)	Basic accuracy (\pm)	Stability (one year) ³	Maximum resistance
Foil	0.5 to 2	0.5 to 3	5 to 1000 ppm	5 ppm ⁴	250 k Ω
Wirewound	1 to 10	NA ⁵	20 to 1000 ppm	20 ppm ⁴	1 M Ω
Thin film (NiCr)	10 to 100	1 to 5	To 50 ppm	50 ppm	1 M Ω
Thin film (TaN)	25 to 100	2 to 5	0.1 to 2%	0.1%	25 M Ω
Thick film	25 to 300	2 to 50	2 to 5%	0.1 to 1%	2 G Ω
Metal film	15 to 100	NA	0.1 to 5%	0.1%	10 M Ω
Carbon film	250 to 1000	NA	5%	2%	50 M Ω

Notes: 1. Vendors may improve on standard specifications by selection or with custom designs.

2. Temperature range: -40 to $+125^{\circ}\text{C}$

3. Shelf-life conditions

4. Hermetically sealed

5. NA=Not applicable

0.1% is equivalent to 1000 ppm

Figures $>0.1\%$ shown in %

Figures $<0.1\%$ shown in ppm

over new processor configurations, analog-design faithfuls can delight in studying today's precision-resistor architectures. In fact, your circuit designs can benefit immensely if you have intimate knowledge of the intricacies of construction of these otherwise basic parts.

A key difference between traditional wirewound resistors and the more modern foil and film parts is the method of mounting the resistance element within the component. Wirewound resistors naturally consist of wire (usually nickel chromium) loosely wound on a former. Foil and film use a planar construction, with the element bonded to a flat substrate.

The process of constructing a foil resistor consists of bonding a 2.5- μm strip of nickel chromium foil to a ceramic substrate. The foil is then photoetched, leaving a pattern with a current path that snakes back and forth across the substrate. The pattern incorporates extra paths for trimming manually or by laser to produce overall precise resistance values.

Traditional thin-film technology involves sputtering tantalum nitride onto a silicon substrate and photoetching to produce a resistance track. This process produces stability down to 25 ppm/ $^{\circ}\text{C}$, which is useful for high-resistance networks. The more-recent nickel chromium on alumina substrate thin-film process improves performance across its resistance range. A key feature is the thermal conductivity of the substrate, which tends to equalize the temperature of all resistors in a network. Vendors claim 0.5-ppm/ $^{\circ}\text{C}$ tracking TCR, and 5 ppm/1000 hours at 125 $^{\circ}\text{C}$ stability tracking for resistors in networks using this technology.

Whereas the TCR of a wirewound resistor relies solely on the characteristics of wire, the TCR of foil devices depends on two effects. One element is the TCR of the metal foil itself, but a second effect

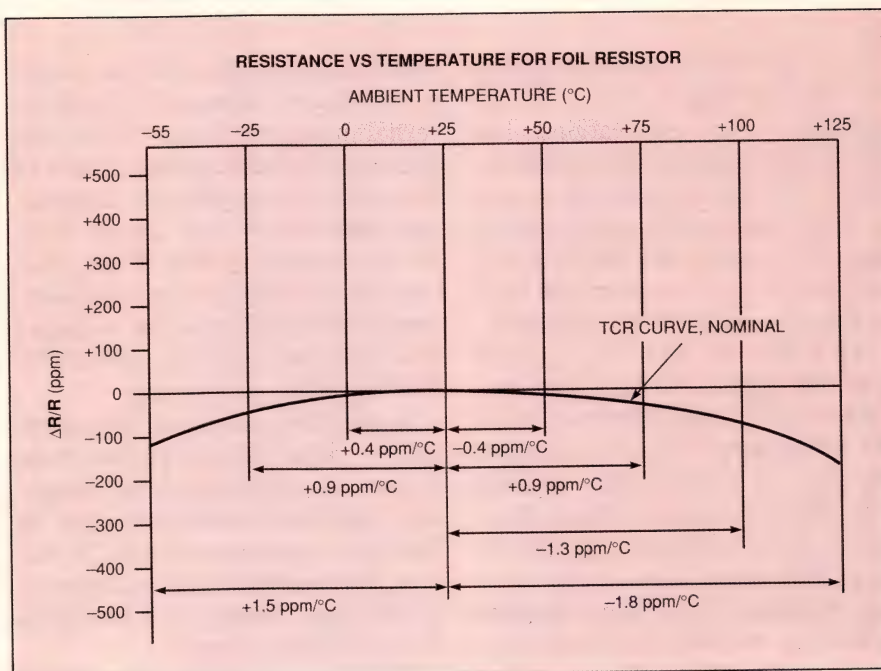


Fig 1—The characteristic variation of resistance with temperature for a foil resistor results when low substrate expansion restrains and compresses the foil at high temperature, reducing its resistance. (Courtesy Alpha Electronics)

arises from the differential linear TC of expansion between foil and substrate material. Because metal foil expands faster than substrate material, the effect is to compress the foil with rising temperature, which tends to decrease its resistance. This decrease counteracts the natural rise in resistance due to the foil's TCR alone and results in the inverted-curve response shown in Fig 1. A similar effect occurs with thin-film types, but because the film is approximately 100 times thinner than foil, a greater TCR results.

Foil sandwich foils TCR error

The VHP100 and VHP101 series of foil resistors from Vishay use an innovative construction technique to produce the ultimate in stable TCR. This ultra-low TCR results from the construction of a foil-substrate-foil sandwich. With half the foil resistance on each side of the substrate, the sandwich's tendency to curl up due to differential linear TC of expansion of foil and substrate is much less than with a

single-sided foil resistor. The result is a TCR performance of 0.3 ppm/ $^{\circ}\text{C}$ max for 15 to 45 $^{\circ}\text{C}$ ambient temperature, or 0.6 ppm/ $^{\circ}\text{C}$ over -55 to +125 $^{\circ}\text{C}$.

The distinct difference in construction between foil and wirewound resistors channels each type to different ac-design applications. The coil construction of wirewound devices, even when bifilar-wound, limits their application to low-audio-frequency-range designs. Foil's planar structure produces resistors with typical inductance of 0.1 mH and capacitance of 1 pF, enabling useful designs from dc to 50 MHz.

In many applications using precision resistors, the stability of the ratio between resistors is more important than their absolute stability. In a simple inverting- or noninverting-amplifier configuration, the dc gain of the amplifier primarily depends on the ratio of two resistors. Maintaining the resistors' ratio with temperature and time therefore stabilizes the amplifier's gain. Foil and thin-film's ability to create two closely-matched resis-

C O M P O N E N T S

tors on the same substrate and in the same package is clearly advantageous in such applications. You can obtain matched wirewound resistors, but this requires the vendor to apply additional manufacturing controls to ensure the use of identical wire for each resistor, and then to keep the matched set together.

Although at first sight TCR tracking appears to be a panacea, without care, other effects can mask the advantages. Take, for example, the case of a 100:1-ratio resistor pair. When you apply voltage, dissipation in each resistor will also be in a 100:1 ratio. Because the thermal resistance of the larger resistor is likely to be lower than that of its mate, the temperature-rise difference in the two resistors may not be as high as 100:1, but it will be appreciable.

In this case, the resistance drift in each resistor will depend on its absolute TCR. A similar situation arises when the temperature difference is due to an ambient variation across the device. Tracking TCR provides optimal benefit when a resistance ratio is close to unity, when self-heating is negligible, or when you can be sure that both resistors experience uniform temperature rise. Otherwise, absolute TCR, not tracking TCR, remains a key specification.

Thermal EMFs receive attention

Another data-sheet specification that deserves careful scrutiny concerns thermal EMFs generated within the resistor. These EMFs, of several $\mu\text{V}/^\circ\text{C}$ magnitude, appear at the internal junctions of the different metals of resistance element and copper leadout. In low-level designs, a $1\text{-}\mu\text{V}/^\circ\text{C}$ thermal EMF will be just as detrimental as a drift caused by a $1\text{-ppm}/^\circ\text{C}$ TCR.

If the temperature of the two internal junctions is equal, then the EMFs generated will also be equal. Overall, because the two EMFs are of opposing polarity, they cancel

out. To achieve this situation, resistor designers endeavor to bury internal junctions deep within the package. This arrangement tends to even out internal junction temperature differences that always exist on the external portion of the leadouts due to drafts and fixed ambient-temperature gradients. The success of this technique results in $<0.1\text{-}\mu\text{V}/^\circ\text{C}$ thermal EMF performance.

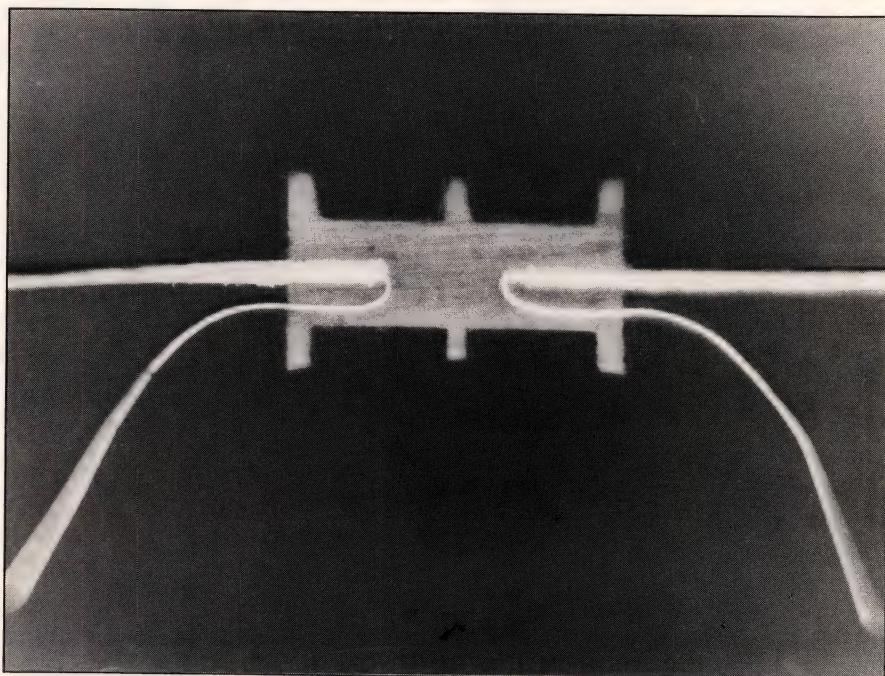
In practice, you should mount resistors broadside-on rather than end-on (as determined by component leadouts) to the direction of heat flow across your circuit. In this way, you maintain thermal symmetry in your design and minimize thermal EMFs overall.

Long-term stability of precision resistors remains an issue that resistor enthusiasts debate hotly. Proponents of wirewound claim superior performance because, once formed in the component, the wire element remains loosely wound and without stress. In contrast, foil and thin-film elements remain bonded to a substrate and are constantly

under stress. In either case, vendors bake components prior to shipment in an effort to release manufacturing stresses. Whatever you believe, it is certain that hermetically sealed resistors in any technology produce the lowest long-term drift.

Suppliers consolidate

As resistor stability has improved, the number of suppliers for precision resistors has diminished. The last five years have seen vigorous acquisition programs leaving only a handful of suppliers in the business. Foil-technology components mainly come from two companies: Vishay in the US and Alpha Electronics in Japan. Electro-Films and Sfernice major in precision thin-film parts, and General Resistance and Vishay maintain traditional wirewound production. Caddock specializes in precision networks and accurate, very-high-resistance-value ($25\text{ ppm}/^\circ\text{C}$ TCR at $1000\text{ M}\Omega$) parts, but using thick-film technology. Isabellenhütte in Germany



Burying junctions between leads and elements deep inside a resistor body and less than 2 mm apart reduces thermal EMFs to $<0.2\text{ }\mu\text{V}/^\circ\text{C}$, as General Resistance's wirewound Econister family demonstrates.

Actual output

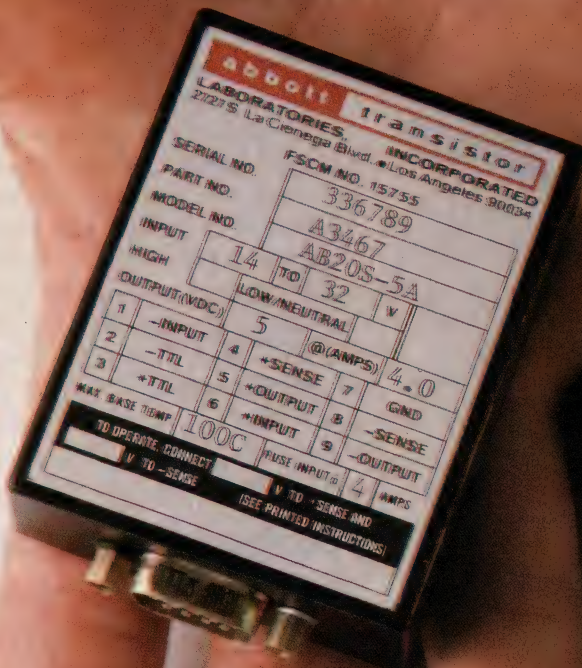
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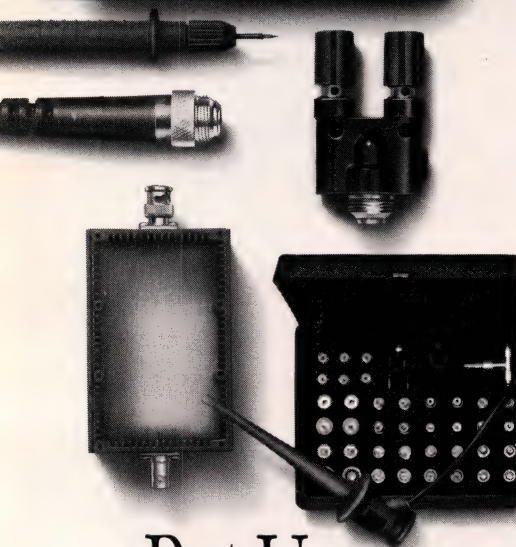
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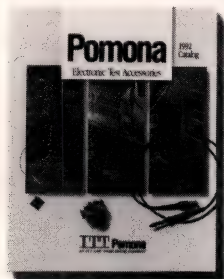
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COMPONENTS

also offers foil devices but specializes in low resistance values—from 5 mΩ to 100Ω—for current-sensing applications.

One significant difference between vendors of foil and wirewound is that all foil manufacturers "roll their own," and can therefore apply strict in-house controls on producing the vital element material. Wirewound vendors are at the mercy of outside sources for the essential wire, and are therefore subject to possible batch-to-batch variations.

Of the three main precision-resistor technologies, foil is already favorite for general low-level signal designs. Wirewound components will remain popular for power applications and as a lower-cost alternative for dc designs. Advances in

thin-film components pose the greatest threat to foil in the long-term, but only in designs using resistance networks. **EDN**

References

1. Gerber, George, "Temperature tracking of a pair of resistors," Technote 2, Vishay.

2. Gerber, George, "Precision resistors and resistor networks," Technote 17, Vishay.

3. Gerber, George, "Does good tracking of resistors with temperature ensure good ratio stability?" Technote 22, Vishay.

Article Interest Quotient
(Circle One)

High 473 Medium 474 Low 475

For more information . . .

For more information on the precision resistors discussed in this article, circle the appropriate numbers on the Information Retrieval Service card or use EDN's Express Request service. When you contact any of the following manufacturers directly, please let them know you read about their products in EDN.

Alpha Electronics

3K Bldg, 2-4-7 Kojiki
Chiyoda-Ku
Tokyo, Japan
(3) 3258-4095
FAX (3) 3258-4097

Circle No. 665

In UK:

Rhpoint Components

Holland Rd
Hurst Green, Oxsted RH8 9BB, UK
883-717988
FAX 883-712938

Circle No. 666

Caddock Electronics

1717 Chicago Ave
Riverside, CA 92507
(714) 788-1700
FAX (714) 369-1151

Circle No. 667

In UK:

Rhpoint Components

see address above

Circle No. 668

Electro-Films

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FAX (401) 738-4389

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General Resistance

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FAX (203) 481-8937

Circle No. 670

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Isabellenhütte Heusler

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In UK:

Sfernice

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953-602525
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Circle No. 675

Vishay Resistive Systems

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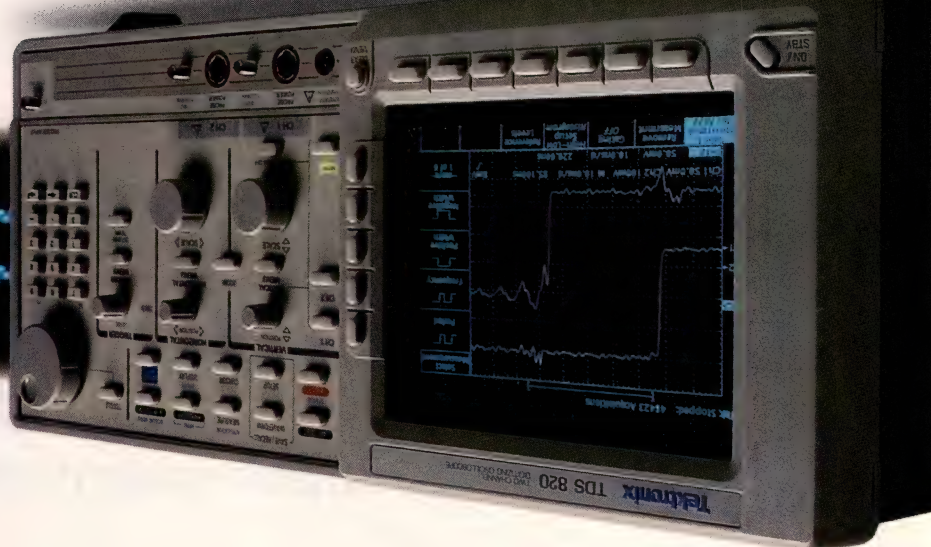
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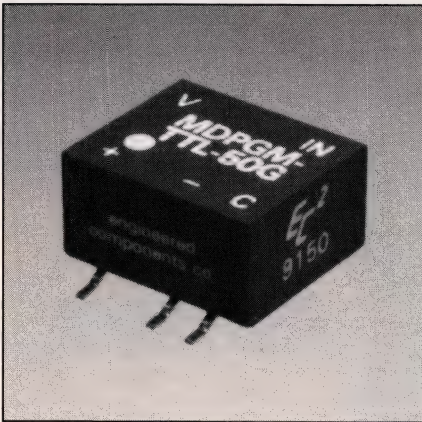
Test and Measurement

CIRCLE NO. 62

Miniature generator modules available in surface-mount packages

MDPGM-TTL pulse generators are housed in mini-DIP modules, which come in surface-mount (gull-wing and J-lead terminations) or through-hole versions and measure $0.5 \times 0.4 \times 0.25$ in. The devices employ a hybrid construction that utilizes the technologies of active integrated circuitry and passive networks made up of inductive, capacitive, and resistive elements.

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input step. This output can drive eight Schottky TTL loads. The generated pulse is inverted internally to provide a negative pulse output

one propagation-delay time later than the main output.

To function properly, the generator input step must hold positive for at least 10 nsec. After the 10-nsec minimum, input-pulse-width duration has no effect on the width of the output pulse. The generators require a 5V supply and operate over the 0 to 70°C range. Customer-specified random-pulse-width outputs are available as an option. \$9 (100). Delivery stock to six weeks ARO.

Engineered Components Co., Box 8121, San Luis Obispo, CA 93403. Phone (805) 544-3800. FAX (805) 544-8091. Circle No. 730

NEMA-compatible miniature terminal provides a complete operator interface

The Model 3902-04 miniature terminal combines a 4-line \times 20-character vacuum fluorescent display with a standard 33-key, sealed-metal-dome keypad. The keypad provides tactile feedback and features ESD shielding. The unit is drip proof (meets the requirements of NEMA 12 when used with the factory-provided gasket) and operates over the 0 to 70°C temperature range, which makes the device suitable for harsh environments.

The terminal is easy to customize for different applications. The basic unit is available with several standard filter colors. Users can apply switch legends to the slide-in legend strips. The device's electronics can implement a custom switch configuration as large as an 8×8 array.

The terminal's characters are 0.2 in. high and are configured in a 5×7 dot matrix. The blue-green



characters are software dimmable to three levels of brightness. In addition to the 96-character US ASCII character set, the unit can display European and scientific characters. The terminal's 7-kbyte EEPROM can store as many as 127 canned display and switch-output messages.

The module has both RS-232C and RS-422 interfaces. Input and

output data can be configured as 7- or 8-bit words with odd, even, or no parity. The terminal can transmit data at rates of 1200 to 19,200 baud. The $11.4 \times 6 \times 1.73$ -in. unit operates from a 5V supply. \$370 (100).

IEE Inc., 7740 Lemona Ave, Van Nuys, CA 91409. Phone (818) 787-0311, ext 418. FAX (818) 901-9046.

Circle No. 731

Vertical Mount Fixed Resistors

Series RSS Vertical Mount Metal Oxide Fixed Resistors feature self-standing, snap-in terminals, and they exhibit an excellent high frequency response and low inductance, making them suitable for PC board mounting in power supplies, switching regulators, monitors, printers, and color TVs.

Model RSS3FB is rated at 3W with a resistance range of 1 Ω to 100K Ω . Model RSS5FB is rated at 5W with a resistance range of 1 Ω to 2.4K Ω . Both are available in 15mm and 25mm heights. Free samples are available, contact Noble at 708/364-6038.

CIRCLE NO. 63



2-, 4-Bit and 5-Bit Rotary Encoders

Noble SDB161 2-, 4- and 5-bit encoders are compact (21mm ϕ) with a low profile (under 10mm height). Built with a sturdy diecast and steel construction, these encoders offer long life and reliability.

SDB161 encoders are for relative (2-bit) and absolute (4-bit, 5-bit) reference applications. 2-bit switches offer 36 detented positions; 4-bit switches offer 12 or 16 detented positions; 5-bit switches offer 24 or 32 detented positions. All encoders feature continuous rotation. The 2-bit is available in gray code; the 4- and 5-bit versions offer either binary or gray code. Custom designs can be accommodated. For free samples, contact Noble at 708/364-6038.

CIRCLE NO. 64



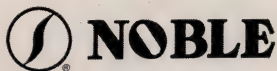
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CIRCLE NO. 65



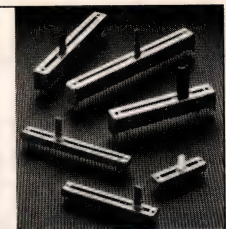
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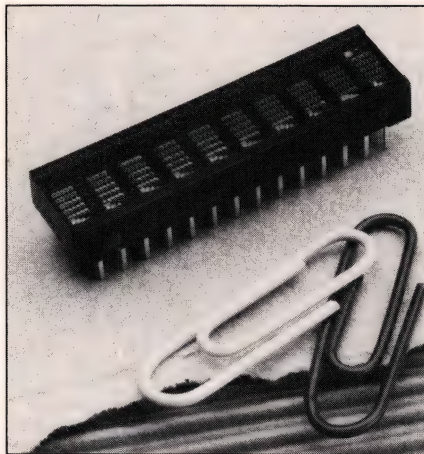
CIRCLE NO. 66



Multicharacter LED display modules minimize panel real-estate requirements

The SCD558X and SCD5510X additions to the Slimline Intelligent Display family are 8- and 10-character display modules, respectively. Suitable for harsh environments, the 0.4-in.-tall packages require 60% less front-panel space and 30% less power than conventional 5×7 dot-matrix displays. These savings result from using nonstandard 5×5 dot-matrix LED arrays of 8 and 10 characters per component.

The dot-addressable modules work with the serial peripheral-interface ports of most μ Ps. The CMOS devices have a 200-bit RAM to generate user-defined characters. The modules are X-Y stackable to create short text displays.



The modules include a power-down mode that requires 250 mW. The units also have onboard intelligence, including column and row

drivers, which are easily accessible through the serial interface.

The modules are available in standard red, high-efficiency red, yellow, green, and high-efficiency green. The outside dimensions of the display area measure 1.5×0.4 in. for both the 8- and 10-digit versions. The mounted height of the modules is 0.2 in. The displays operate over the -40 to +85°C range and are housed in 28-pin plastic DIPs. SCD558X, \$23.70 to \$26.60; SCD5510X, \$29.60 to \$33.25 (100).

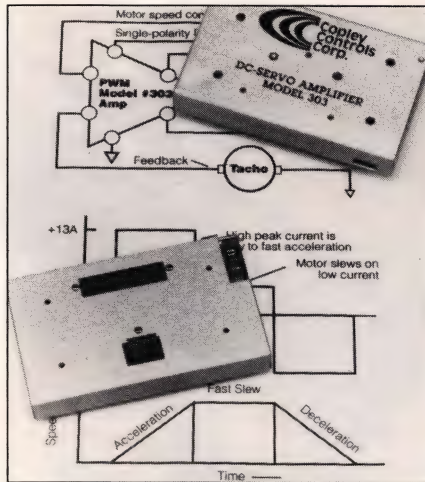
Siemens Components, Optoelectronics Div, 19,000 Homestead Rd, Cupertino, CA 95014. Phone (408) 725-3423.

Circle No. 732

High-efficiency servoamplifier delivers $\pm 6A$ at $\pm 75V$ continuously

The Model 303 PWM servoamplifier develops 4-quadrant $\pm 6A$ at $\pm 75V$ continuously and $\pm 12A$ peak for fast motor acceleration. The unit operates from a single-polarity supply. It features a 22-kHz switching frequency, which puts motor hum beyond the human hearing range; a 3-kHz bandwidth to maximize servo accuracy; and a 95% efficiency.

A resistor lets users shape the amplifier's gain-bandwidth response. The unit incorporates a technique for subtracting armature resistance so that motor back EMF can serve as speed-control feedback. For applications in which low cost is critical, the amplifier can operate without tachometer feed-



back. The unit can operate as a current source or a voltage source. A MOSFET-bridge output stage lets the unit develop bipolar out-

put power from a 16 to 80V supply.

You can mount the 6.7×4×1.1-in. unit on a pc board for integration into control-system electronics. You can also mount the unit on a bulk-head surface edgewise, like a book on a shelf, or into a standard VME rack using a Eurocard adapter. Output power-connector options include a standard Molex screw terminal, solder connections, or a plug-in pc-board mounting base. Motion-control input and tachometer/armature-feedback connections are made via shielded and grounded Molex terminations. \$215 (100).

Copley Controls Corp, 410 University Ave, Westwood, MA 02090. Phone (617) 329-8200. FAX (617) 329-4055.

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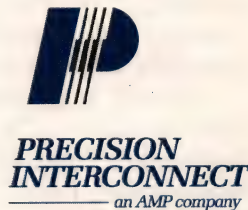


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CIRCLE NO. 67

EDN July 20, 1992 • 101



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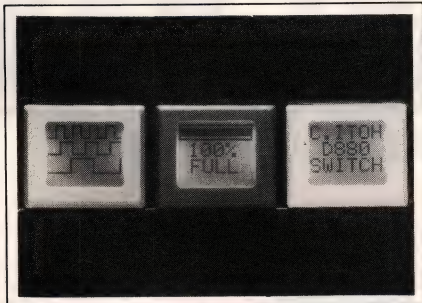
Components

Digital Switch

Designed for impact-detection and momentary switch applications, the SW-100 utilizes a piezoelectric polymer to provide noise-free, digital output switching. The unit features a MOSFET circuit that consumes no power during its normally open state. In response to a direct contact force, the piezoelectric polymer momentarily triggers the MOSFET, which then provides momentary closure.

The SW-100 suits low-level switching applications. The unit has a maximum switching capability of 50V. The switch exhibits no pitting, corrosion, or bouncing normally associated with hard-contact switches; as a result, the switch has a minimum operating lifetime of 10 million cycles. \$2.95 (10,000).

Elf Atochem Sensors Inc, Box 799, Valley Forge, PA 19482. Phone (215) 666-3529. FAX (215) 666-3509. Circle No. 368



Switch Module

The D880 LCD module integrates a low-power graphics LCD, which utilizes supertwist technology, with a custom IC driver and multicolor backlighting. The entire unit fits in the key cap of an spst, momentary contact switch that measures approximately 1 in².

The display consists of 864 pixels configured in a 24×36 matrix that provides full screen graphics. With a 5×7 font, the display has an 18-character capability—3 lines of 6 characters. The red and green backlighting can be changed by revers-

ing the 5V applied to the LED terminals. Amber is obtained by using an ac voltage across the LED terminals. \$37.50 (250).

C Itoh Technology Inc, Box 19657, Irvine, CA 92713. Phone (800) 347-2484, ext 4529. FAX (714) 757-4423. Circle No. 369

Solid-State Relay

The LH1514 solid-state relay is a dpst normally open switch that can replace high-frequency electromechanical relays in some applications. The relay is designed for balanced switch applications. To provide high load isolation, internal circuitry shunts high-frequency signals between the two poles when the relay is off.

The relays are constructed using a GaAlAs LED for actuation control and an integrated monolithic die for the switch output. The die, fabricated in a dielectrically isolated BCD MOS technology, includes a photodiode array, switch control circuitry, and NMOS switches. The relays are available in 80-pin plastic DIPs or in surface-mount, 8-pin gull-wing packages. \$0.375 (10,000). Delivery, stock to six weeks ARO.

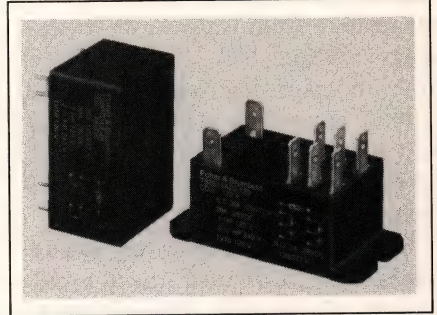
AT&T Microelectronics, Dept AL-520404200, 555 Union Blvd, Allentown, PA 18103. Phone (800) 372-2447; in Canada, (800) 553-2448. FAX (215) 778-4106. Circle No. 370

Power Relay

The T92 relay can switch loads as high as 30A at 277V ac. Occupying approximately 3 in.³ of space, the relays are available in either pc-board or panel-mount versions.

The silver cadmium oxide contacts are available in dpst or dpdt configurations. Both ac and dc coils are available. Life expectancy when switching a 240V, 30A load equals 100,000 operations for units with ac

coils and 300,000 operations for devices with dc coils. The relays meet the requirements of UL873 and UL508; the 4000V dielectric



strength rating between coil and contacts also meets VDE requirements. An unsealed plastic dust cover and an immersion-cleanable, tape-sealed plastic case are available. \$3.53 (5000).

Potter & Brumfield Inc, 200 S Richland Creek Dr, Princeton, IN 47671. Phone (812) 386-2276. FAX (812) 386-2335. Circle No. 371

Digital Panel Meter

The LED display in the DMS-30PC 3-1/2 digit DPM (digital panel meter) comes in nine colors. The unit has an integrated bezel and is fully encapsulated. The meter has a bipolar differential input and offers ranges of ± 0.2 , ± 2 , and ± 20 V dc.

Key parameters for the -30PC include a 10T Ω input impedance, a 0.05% ± 1 count accuracy, and a 0 to 60°C operating range. Common mode rejection equals 86 dB. A Display-Test pin is available to ensure that all LED segments are functioning properly.

All DMS-30PC models operate from a 5V supply and draw 150 mA. All units are overvoltage protected to ± 250 V and have a common mode voltage tolerance of ± 2 V dc. From \$45 for a model with red LEDs.

Datel Inc, 11 Cabot Blvd, Mansfield, MA 02048. Phone (508) 339-3000. FAX (508) 339-6356. Circle No. 372

Micropower Voltage Reference

The LM4040 family of bandgap voltage references includes devices with output voltages of 2.5, 4.1, 5.0, 8.2, or 10.0V and a voltage-tolerance range from 0.1% to 2.0%. Average voltage TC is 100 ppm/°C over an operating temperature of -40°C to +85°C. Operating current is 60 μ A to 15 mA. In TO-92, SO-8, and SOT-23 packages, \$0.85 (100).

National Semiconductor, Industriestrasse 10, D-8080 Fürstentfeldbruck, Germany. Phone 8141-103514. FAX 8141-103515.

Circle No. 373

Transient-Suppression EMI Filter

The TVS range of feedthrough filter capacitors incorporates a transient-voltage suppression element.

The filter provides attenuation of 2 dB and 75 dB at 100-kHz and 10-GHz, respectively. Clamping voltages range from 5 to 15.5V and withstand transient currents to specification IEC-801 part 5. £3 to £8 (1000).

Oxley Developments Co, Ulverston, LA12 9QG, UK. Phone 229-52621. FAX 229-55090.

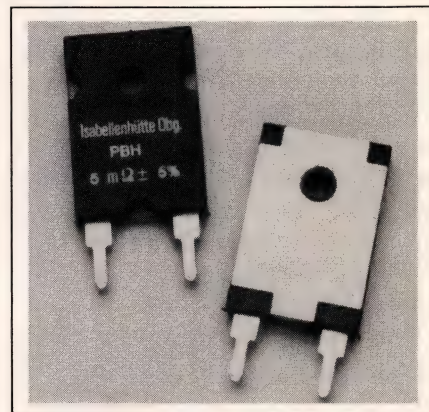
Circle No. 374

Power Resistors

Type PBH resistors have a 10W power rating in 40°C still air. Housed in TO-247 packages, the units have a low internal heat resistance so they remain accurate to within 0.5% of nominal resistance value at full power.

Resistance values for PBH devices range from 2 m Ω to 100 Ω . Standard tolerance values equal

0.5, 1, and 5%, and the temperature coefficient (20 to 60°C) measures 50 ppm/°C max. Dielectric withstand-



ing voltage is specified as 500V ac. \$1.50 to \$3 (10,000). Delivery, stock to eight weeks ARO.

Isotek Corp, 566 Wilbur Ave, Swansea, MA 02777. Phone (508) 673-2900. FAX (508) 676-0885.

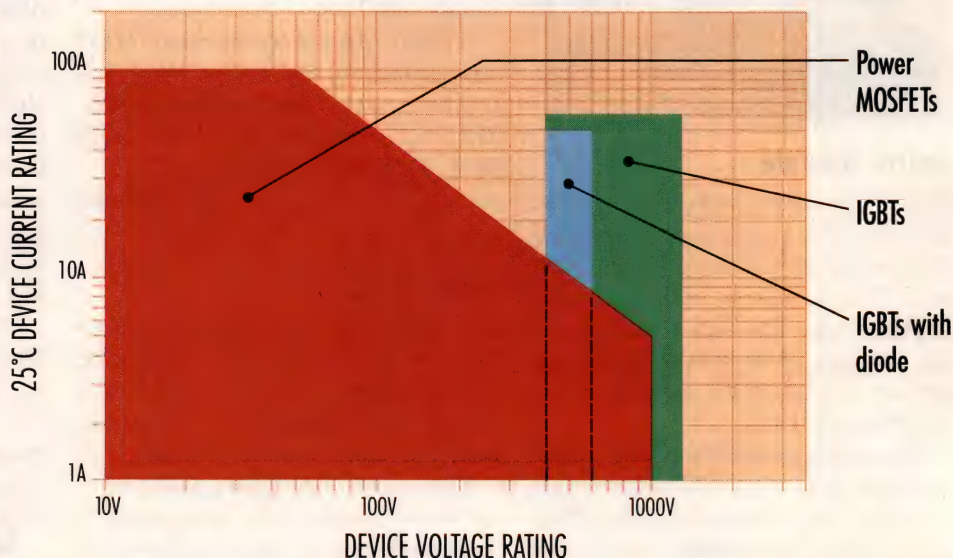
Circle No. 375

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Here's the fast way to get your motor started. Call Harris. We've got everything you need for every kind of motor control application. Including power MOSFETs, IGBTs, ultra-fast rectifiers, MOVs and IC drivers. So tap the power of Harris. Just give us a call today.



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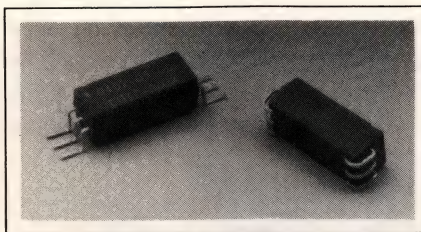
Chip Inductors

GLU Series nonmagnetic chip inductors are designed for a range of surface-mount applications. Key features are their small size ($2.5 \times 2 \times 1.6$ mm), high self-resonant frequency (160 MHz min), and tight tolerances ($\pm 10\%$).

The GLU line's 21 models have inductance values ranging from 0.01 to $0.47 \mu\text{H}$. Q values of 10, 15, and 20 are available. Rated current figures range from 125 to 280 mA, and self-resonant frequency values range from 160 to 2500 MHz. The inductors are fully encapsulated and operate over a -20 to $+85^\circ\text{C}$ range. Carrier and reel packaging is standard. \$0.41 (2000).

Sprague-Goodman Electronics Inc., 134 Fulton Ave, Garden City Park, NY 11040. Phone (516) 746-1385. FAX (516) 746-1396.

Circle No. 376



Reed Relays

Series 9400 surface-mount reed relays are designed for applications ranging to 2 GHz. They incorporate a 50Ω coaxial shield, exhibit 1-pF capacitance from contact to shield, and transmit a leading pulse-edge rise time of 147 psec. Typical values for isolation, insertion loss, and VSWR at 250 MHz are 45 dB, -0.3 dB, and 1.10, respectively.

The units are housed in a 0.255×0.55 -in. package and are available with J, gull, and radial leads in 4- and 6-pin versions. The packages have a smooth top surface

to accommodate pick-and-place equipment. The units can withstand soldering temperatures of 221°C . \$1.80 to \$3 (OEM qty).

Coto Corp., 55 Dupont Dr, Providence, RI 02907. Phone (401) 943-2686. FAX (401) 942-0920.

Circle No. 377

Military Relays

FCA-210, -410, and -610 magnetically polarized, monostable relays are on the QPL to MIL-R-6106. All are rated for loads of 10A at 28V dc or 115/230V ac.

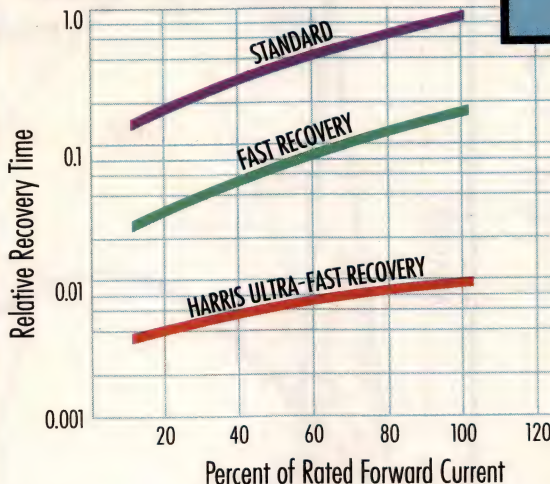
Contact configurations for the -210, -410, and -610 relays are dpdt, 4pdt, and 6pdt, respectively. Package sizes range from $1.025 \times 0.525 \times 1.01$ in. for the -210 to $1.053 \times 1.483 \times 1.01$ in. for the -610. FCA-210 and -410 units withstand 200g shocks; the -610 devices are

MOTOR RUNNING

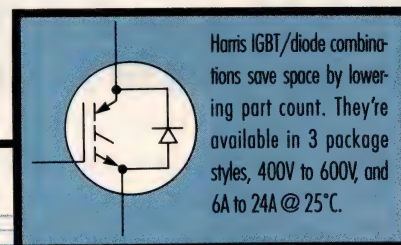
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 - Only Harris provides UIS/SOA curves
 - ESD rated and protected devices
- | | N-CHANNEL | P-CHANNEL |
|--------|--------------|--------------|
| TO-220 | | 65m Ω |
| TO-247 | 10m Ω | 26m Ω |

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3.5 V dc
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6000 V ac

INDUSTRY'S WIDEST RANGE OF PACKAGES

Radials
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Industrial high-energy MOVs

rated for 50g. The operating range for all relays is -70 to $+125^{\circ}\text{C}$. All units are available with socket pins, pc-board pins, or solder hooks. Both bracket and stud mountings are available. \$125 for FCA-610 relays. Delivery, 10 weeks ARO.

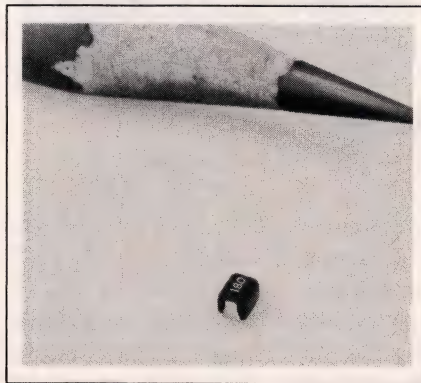
Struthers-Dunn/Hi-G Co, Lambs Rd, Pitman, NJ 08071. Phone (609) 589-7500. FAX (609) 589-2619. Circle No. 378

Circuit Breakers

The IML family of circuit breakers includes 1-, 2-, and 3-pole versions. In addition to the on and off designations, the breakers have a mid-trip position. This feature simplifies the problem-detection task.

The units are available with ratings of 0.5 to 70A at 80V dc and 0.5 to 50A at 240V ac. An optional fault-isolation switch, available on

the single-pole units, can be used to activate an audible alarm. The breakers are UL recognized, CSA certified, and meet international



spacing requirements of IEC-157-1 and VDE 0660. All models are available in a screw panel-mount or snap-in style. \$14 to \$16 (OEM qty).

Airpax, Woods Rd, Cambridge, MD 21613. Phone (410) 228-4600. FAX (410) 228-8910. Circle No. 379

3-State Crystal Oscillator

The IQXO family of crystal oscillators covers a frequency range of 250 kHz to 70 MHz with frequency stability of 25, 50, or 100 ppm. Normal operating power requirements are 5V at 30 mA. A disable signal places the output to a high impedance state, and standby current is 50 μA . Hermetically sealed metal-can 8- or 14-pin DIP, £2.17 (1000).

International Quartz Devices, North St, Crewkerne TA18 7AR, UK. Phone 460-77155. FAX 460-76602. Circle No. 380

Resistor networks

PRN110 and PRN111 resistor networks are housed in small-outline packages that have a 25-mil lead pitch. The surface-mountable units are available in isolated and bused-resistor configurations and come in

KEEP TRANSIENT PROBLEMS FROM

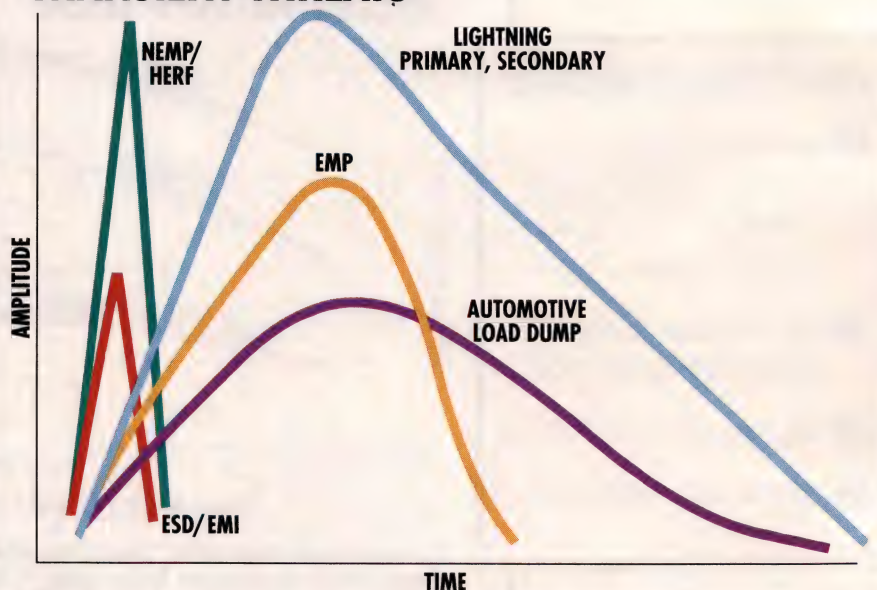
Once a transient has fried your circuit, it's a very permanent problem. That's why you need surge protection from Harris.

We're a leading supplier of transient surge suppressors. With products that can stop everything from a lightning strike. To the dreaded HERF (high energy radio frequencies). In fact, our ceramic chips and MOVs cover a range of voltages from 3.5V dc to 6000V ac. From a tiny 10th of a joule to tens of thousands of them.

And Harris is your one and only source for QPL MOVs. So suppress those transient surges. Just give us a call today.



TRANSIENT THREATS



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Components

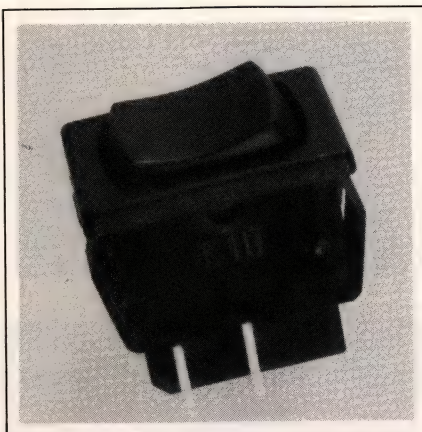
16-, 20-, and 24-pin narrow-body packages.

Resistance values for both lines range from 10Ω to 1 MΩ. Typical tolerance equals ±0.1%. The thin-film resistors have a temperature coefficient of ±25 ppm/°C and a 100V maximum operating voltage. Minimum insulation resistance equals 10¹⁰Ω, and operating range spans -55 to +150°C. Approximately \$0.95 (10,000). Delivery, six weeks ARO.

California Micro Devices Corp,
215 Topaz St, Milpitas, CA 95035.
Phone (408) 263-3214. FAX (408) 263-7846. **Circle No. 381**

Lamp Switch

The GC-509 rocker switch provides savings in on-off switching of pre-heat-start fluorescent lamps. Because the switch features sequential



making and breaking in alternate poles combined with the appropriate momentary or detent action in alternate positions, it's possible to eliminate a separate lamp starter.

When the GC-509 is pressed to the full travel position, the ballast power circuit and lamp starter circuit are each connected to the power supply. When the switch re-

leases to its intermediate position, the lamp starter-circuit contacts are disconnected; the ballast power circuit remains connected. When the switch is returned to the original position, all contacts disconnect. Switch contacts are rated for 3A at 125V ac by UL and CSA. \$0.75 (5000). Delivery, six to eight weeks ARO.

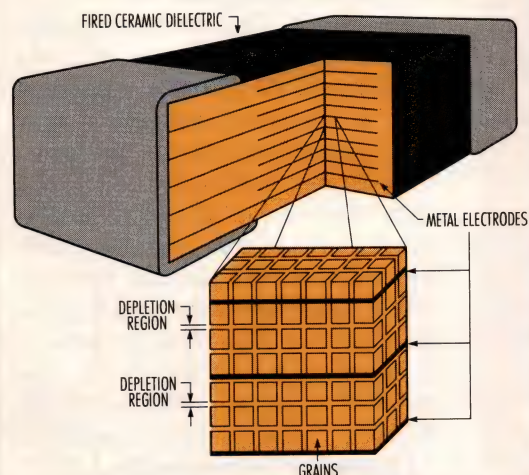
CW Industries, 130 James Way,
Southampton, PA 18966. Phone
(215) 355-7080. FAX (215) 355-1088. **Circle No. 382**

Pressure Sensor

Model MPP-010D, a 10-in. pressure-sensing device, provides a digital output. The unit contains a capacitive-sensing element as well as digital CMOS output circuitry. The sensor output is in parallel format and consists of two 8-bit words

BECOMING PERMANENT

Traditional transient suppressors have their response times slowed by parasitic lead impedances. But Harris's new surface mount surge suppressors feature a unique multi-layer interdigitated construction that results in virtually zero inductance. For response time less than 100 picoseconds. And much better protection.



TRANSIENT THREAT	TYPE OF APPLICATIONS
NEMP	Military, Rad Hard
HERF, EMI	Aerospace
ESD	Instrumentation, Computer Logic
EMP	Motors, Power Supplies, Controls, Medical
Primary Lightning	Transformer, Power Delivery & Distribution, HVAC
Secondary Lightning (Inductive Switching)	Domestic, Industrial, PCs, Medical
Automotive Load Dump	ABS, Engine Management

NEW FORMS OF SURGE SUPPRESSION FROM HARRIS



Connector Pin MOVs

Unique design slips over connector pin, eliminating inductive lead effects



Pin Array Multilayers

Protects all pins of connector, adding negligible weight and space



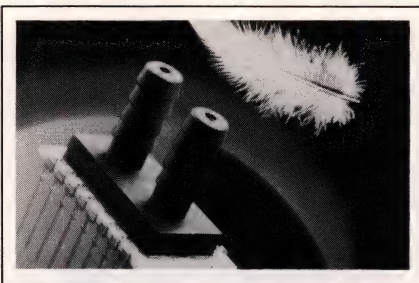
Multilayer Surface Mount Surge Suppressors

Unique lead-less design has virtually zero inductance; improves response time, increases protection

Components

that provide 13 data bits. Inputs and outputs are compatible with standard TTL.

The sensor has a differential input. Accuracy equals 0.5%, and resolution measures 0.05% of full scale. The unit withstands overpressures equivalent to 100 in. of water, and burst pressure equals



200 psi. The MPP-010D is housed in a plastic package and operates from a 5V supply. \$250.

Monolithic Sensors Inc, 2800 W Golf Rd, Rolling Meadows, IL 60008. Phone (708) 437-8090. FAX (708) 437-8144. Circle No. 383

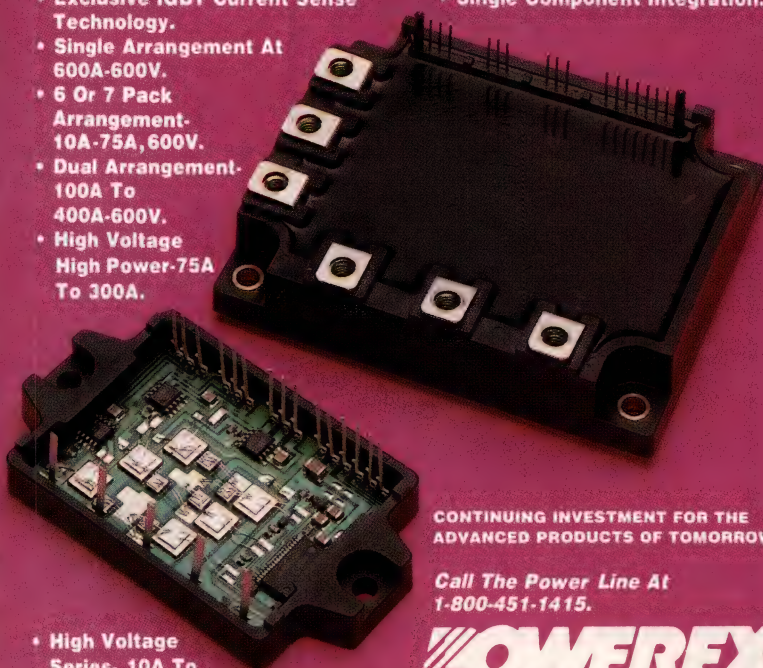
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Electromechanical Relay

The G5V-1 subminiature electromechanical relay measures 12.5 × 7.5 × 10 mm. The unit operates with 150 mW of coil control power and conforms to the FCC Part 68 surge-withstand requirement of 1.5 kV. The relay is also UL and CSA recognized.

Contacts in the G5V-1 relays are configured in a 1 Form C arrangement. The contacts will switch loads as high as 1A. The coil will withstand as much as 200% of rated coil voltage at 55°C. For a 1A, 24V dc load, electrical life for the relay measures 100,000 operations. \$1.19 (1000).

Omron Electronics Inc, Control Components Div, 1 E Commerce Dr, Schaumburg, IL 60173. Phone (708) 843-7900. Circle No. 384

Power Resistors

MP850 Kool-Pak power film resistors have a 50W rating at 25°C case temperature. The resistors employ a noninductive design and are housed in a TO-220 power package that features an integral copper heat sink molded into the package.

Resistance values for the MP-850 units range from 1Ω to 10 kΩ. Tolerances of ±1, ±2, ±5, and ±10% are available. The package requires only a single screw for mounting to the heat sink. The resistor element is electrically isolated by the molded package. \$2 to \$2.50 (10,000). Delivery, six weeks ARO.

Caddock Electronics Inc, 17271 N Umpqua Hwy, Roseburg, OR 97470. Phone (503) 496-0700. FAX (503) 496-0408. Circle No. 385

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Futaba is the leading global supplier of vacuum fluorescent displays and modules. We have the capability, technology, and market knowledge to provide you with the most cost effective display system tailored to your specific application.

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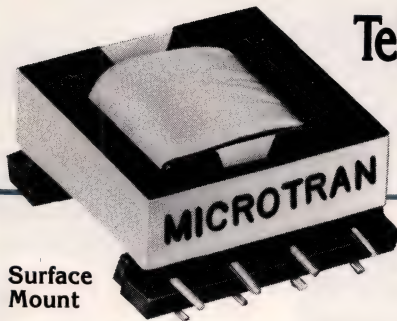
Appliance Control Display.



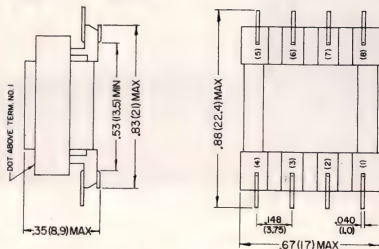
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New Very Low Profile Telecommunication Transformers Designed to meet FCC Part 68

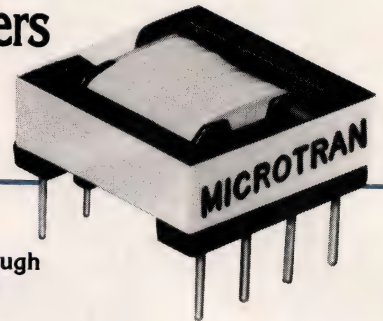


Surface
Mount



Inches(mm)

Fig. A



Through
Hole

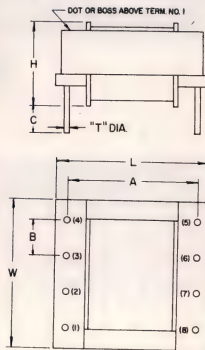


Fig. B

DIMENSIONS Inches(mm)

Part No.	W	L	B	A	H	C	T
TP3106	.615 (15.6)	.65 (16.5)	.148 (3.75)	.541 (13.7)	.315 (8.0)	.142 (3.6)	.024 (.60)
TP3220	.615 (15.6)	.65 (16.5)	.148 (3.75)	.541 (13.7)	.315 (8.0)	.142 (3.6)	.024 (.60)
TP3111	.76 (19.3)	.84 (21.3)	.150 (3.81)	.551 (14.0)	.35 (8.9)	.157 (4.0)	.012 (.30)

FEATURES:

- Frequency Response: 300 to 3500 Hz \pm 0.5 dB
- Power Level: - 45 to + 7 dBm
- Distortion: 0.5% Maximum

- Hipot: 1500 V RMS
- Impedance Matching: \pm 10%
- Longitudinal Balance: 60 dB

- Flammability: Per UL94VO
- Solderability: Per MIL-STD-202, Method 208
- Packaging: Trays - standard; Tubes or reels - optional

Part No.	Primary Impedance	Secondary Impedance	mA DC	Ins. Loss db**	Pri. DCR	Sec. DCR	Schematic	Fig.	Oz (Gm)
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VOICE/DATA COUPLING

TP3106	600 CT	600 CT	0	1.4	76	135	2	B	.2 (6)
TS3106	600 CT	600 CT	0	1.4	76	135	2	A	.2 (6)

DATA MODEM COUPLING—NON-VOICE APPLICATION—FOR 300/1200/2400/9600 BPS MODEMS

TP3111*	600	600	50	1.8 at 2 KHz 0 dBm	49	76	1	B	.4 (11)
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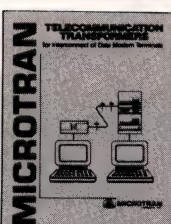
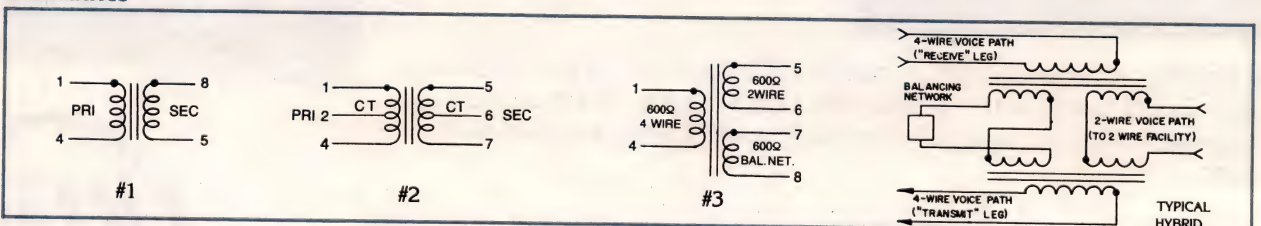
HYBRID—TWO REQUIRED FOR CONVENTIONAL HYBRID OPERATION

TP3220	600 (4W)	600/600	0	1.0	49	70/70	3	B	.2 (6)
TS3220	600 (4W)	600/600	0	1.0	49	70/70	3	A	.2 (6)

*Frequency Response (2 KHz ref.) - 1.8 dB 660 to 800 Hz, 0 dBm; +0.5, -1.5 dB 800 to 3500 Hz, 0 dBm.

**Insertion loss measured at rated DC.

SCHEMATICS



Modified and custom designs also available. Contact factory.

For additional catalog ratings and constructions, request Product Bulletin F234 and Engineering Application Bulletin F232.



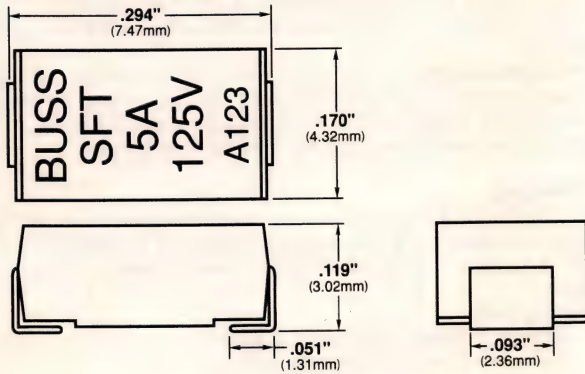
MICROTRAN
company, inc.

145 E. MINEOLA AVE., BOX 236, VALLEY STREAM, NY 11582-0236
(516) 561-6050 FAX: (516) 561-1117

PRODUCT BULLETIN F267-091

Surface Mount Fuse Specification

1.0 Physical Dimensions



Part Number Information

Catalog Symbol	
SFT-	
Ampere Rating	
250mA, 375mA, 500mA, 750mA, 1A, 1.5A, 2A, 2.5A, 3A, 3.5A, 4A, 5A (63mA, 125mA, 7A and 10A ratings will be available in July, 1992)	
Package Code	
TR/	500 pcs., on a 7" reel, 16mm tape width
TR1/	2000 pcs., on a 13" reel, 16mm tape width

2.0 Materials

Body Material:	Thermoplastic, with a rating of 94V-0 as defined by U.L. Standard 94. Material has an oxygen index of 53% per ASTM D2863-77.
Lead Material:	Base-Copper. Barrier-Nickel (50-100 micro inches). Finish-Electroplated Tin (400-500 micro inches with a 2-10% lead content).

3.0 Markings

Body shall be permanently and legibly marked with BUSS®, catalog symbol, ampere rating, and voltage rating. Markings will not become illegible or discolored when the parts are subjected to solvents normally used to remove solder-flux, fingerprints, and other contaminants from printed circuit boards, as tested per MIL-STD-202, Method 215F.

4.0 Electrical Characteristics

Ampere Rating	Maximum Voltage Rating		Interrupting Rating		Typical Melting Integral I ² t (A ² sec)		Typical Total Clearing I ² t (A ² sec)		Typical Voltage Drop (Volts at 100% Rated Current)
	AC	DC	AC	DC	AC	DC	AC	DC	
250mA	125V	125V	50A	300A	7.49 x 10 ⁻⁵	5.1 x 10 ⁻⁶	2.0 x 10 ⁻⁴	6.29 x 10 ⁻⁶	1.015
375mA	125V	125V	50A	300A	3.17 x 10 ⁻⁴	2.18 x 10 ⁻⁵	4.18 x 10 ⁻⁴	2.67 x 10 ⁻⁵	.777
500mA	125V	125V	50A	300A	4.46 x 10 ⁻⁴	3.8 x 10 ⁻⁵	5.74 x 10 ⁻⁴	4.63 x 10 ⁻⁵	.828
750mA	125V	125V	50A	300A	1.72 x 10 ⁻³	2.27 x 10 ⁻⁴	2.59 x 10 ⁻³	2.77 x 10 ⁻⁴	.508
1	125V	125V	50A	300A	.0099	.0069	.0114	.0076	.206
1.5	125V	125V	50A	300A	.0302	.0204	.0345	.0246	.218
2	125V	125V	50A	300A	.0784	.0651	.0891	.0811	.164
2.5	125V	125V	50A	300A	.1775	.1390	.2383	.1574	.145
3	125V	125V	50A	300A	.3355	.2419	.4359	.2664	.163
3.5	125V	125V	50A	300A	.4980	.3812	.6355	.4696	.142
4	125V	125V	50A	300A	.8855	.6785	1.0740	.7829	.140
5	125V	125V	50A	300A	1.7264	1.2912	2.3779	1.3556	.145

1. Interrupting ratings were measured at 95% power factor on AC, and a time constant less than 1ms on DC.

2. Voltage drop was measured at 25°C ± 3°C ambient temperature at rated current with device mounted on a circuit trace.

3. I²t were measured at 50 amp, 125VAC, .95PF (random closing angle) and 300 amps, 125VDC, TC<1ms.

5.0 Trace Geometry Considerations

Trace geometry can affect fuse performance and should be considered when applying any subminiature fuse. Figures 1 and 2 detail the trace geometry used in generating this specification. Suitable trace geometry for a particular application depends on fuse rating, current flow, and ambient temperature. Final determination of suitability for a specific application should be based on empirical testing with all parameters involved.

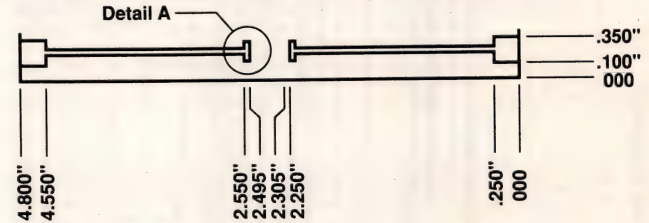


Figure 1

Printed circuit board is .096 inches thick, epoxy glass with 1 ounce copper foil, coated with 300 micro inches of 60/40 tin lead solder.

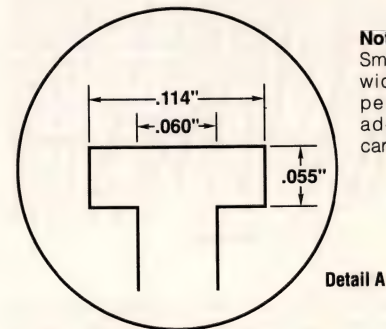


Figure 2

Note

Smaller than recommended trace width may affect the fuse performance by providing additional heat and reducing carrying capacity of the fuse.

6.0 Time Current Characteristics

Carry 100% of rating for 4 hours minimum. Open at 250% of rating in 5 seconds maximum. (See Figure 3).

This specification is intended to clearly present comprehensive product data and provide technical information that will help the end user with design applications. Bussmann reserves the right, without notice, to change design or construction of any products and to discontinue or limit distribution of any products. Bussmann also reserves the right to change or update, without notice, any technical information contained in this catalog. Once a product has been selected, it should be tested by the user in the intended application.

Time/Current Curve

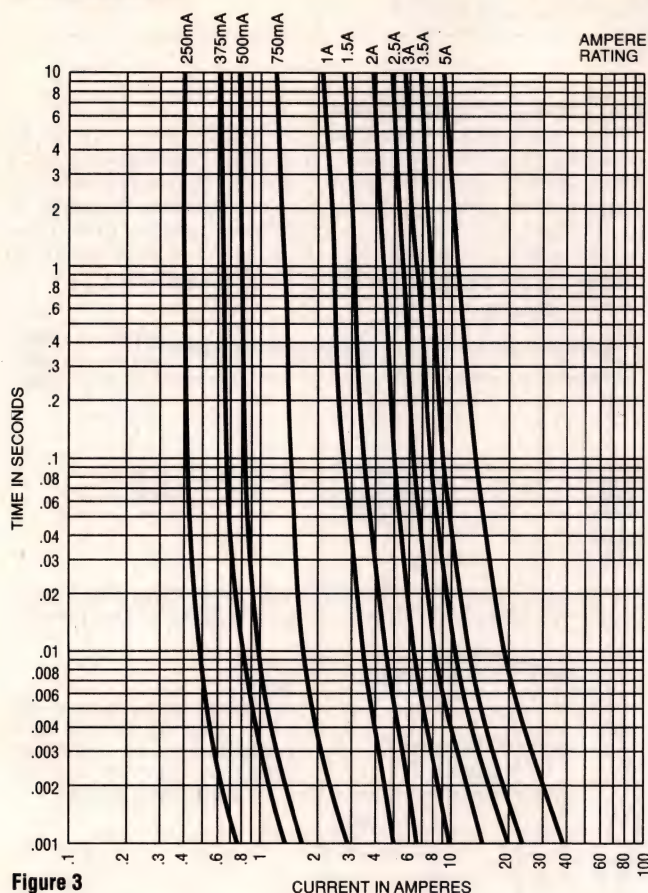


Figure 3

7.0 Thermal Withstand Capability

Infrared Exposure. When the device is exposed to the time-temperature profile detailed in Figure 4, the resistance of the device will not change by more than 5%, as measured after the device has dwelled at room temperature for at least one hour.

IR Time-Temperature Profile

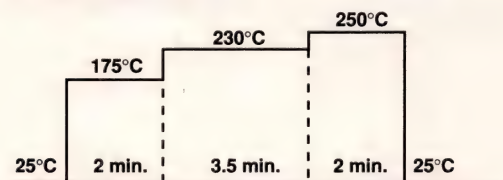


Figure 4

Vapor Phase Exposure. When the device is exposed for ten minutes to the vapor produced by liquid fluorinert FC-5311 at 218°C, the resistance of the device will not change by more than 5%, as measured after the device has dwelled at room temperature for at least one hour.

Resistance to Soldering Heat. MIL-STD-202F, Method B. When device is immersed in a 260°C soldering pot for 10 seconds, the resistance of the device will not change by more than 5% as measured after the device has dwelled at room temperature for at least one hour.

8.0 Mechanical Characteristics

Mechanical Shock. Fuse base shall not chip or crack when dropped from a height of 48" onto a concrete surface.

Vibration. The fuse resistance shall return to within 10% of the original value when the fuse is subjected to a frequency range cycle of one minute in each of the three mutually perpendicular directions having a vibration amplitude of .06 inches peak to peak at a frequency of 10-55Hz. per MIL-STD-202F, Method 204 Condition A.

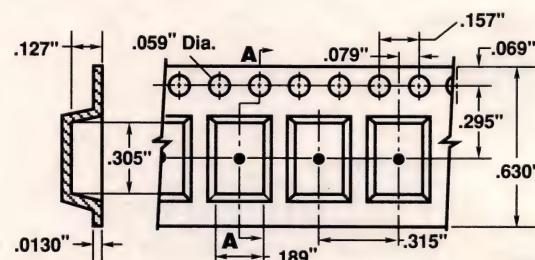
Terminal Secureness. The fuse terminals shall not distort, and the fuse body will not chip or crack when the fuse is placed on a printed circuit board and a vertical downward force of 1/2 kilograms is applied to the top of the fuse for 10 seconds.

9.0 Packaging

All unit packaging material will be manufactured from static inhibiting materials. Tape and reel packaging will comply with EIA Std 481-2, tape width shall be 16mm and reel diameter 7 inches or 13 inches.

Packaging Code

TR/ 500 on a 7" reel, 16mm tape width
TR1/ 2000 on a 13" reel, 16mm tape width



Embossed carrier tape which conforms to the EIA Standards EIA481-2

Carrier made from 3M Brand No. 2701, Non-Conductive Tape Material.

10.0 Agency Approvals

SFT 250mA-5 Amp, 125V
UL Recognized, File E19180, Guide JDYX2
CSA Certified, File 62941, Class 1423-01

11.0 Load Cycling

Load cycling of the SMD TRON® was performed to observe the stability of the resistances and voltage drops for cycling applications. Through measurement of initial and final resistances, an assessment of the reliability of the fuse can be predicted.

Test Conditions. A duty cycle of 60 seconds at rated current and 60 seconds off to make a total period of 120 seconds was used.

Other circuit parameters were:

Amplitude — 100% rated current
Rise Time — 36.8ms (microseconds)
Ripple Average — 15.9mA
System Voltage — 55 volts

Test Criteria. The fuse must complete 200,000 cycles without failure, then resistance and voltage drop measurements are compared to initial measurements, which cannot change by more than 5%.

Test Data:

Average Initial Resistance — 21.11 milli ohms
Average Final Resistance — 20.57 milli ohms
% Change — -2.55%

COOPER

Bussmann

Cooper Industries
Bussmann Division
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St. Louis, MO 63178-4460
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(314) 527-3877 (Customer Service)
Fax (800) 544-2570
(314) 527-1445 (International)

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8000 München 81
Germany
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Fax +49 (0) 89 92404200

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Bussmann International, Inc.
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DK-2740 Skovlunde, Copenhagen
Denmark
Phone +45 42-919900
Fax +45 42-911151

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Fax +65-2275384

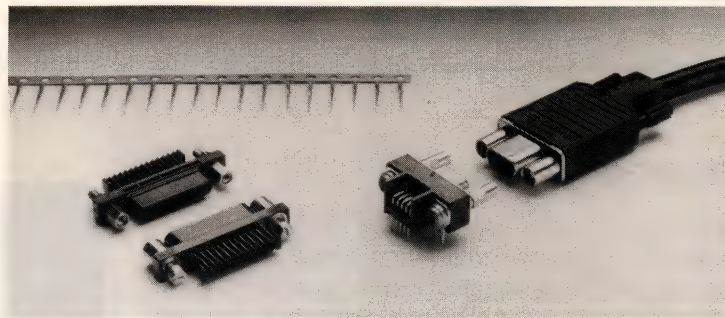
Bussmann
Cooper (U.K.) Limited
Beswick Works,
Frome, Somerset BA11 1PP
England
Phone +44-373-464311
Fax +44-373-473175

The Micro-D MDS/MDSM product line offers a half-pitch .050" solution to commercial applications in need of a microminiature D-type connector.

Requiring only one-third the space of conventional D Subminiature connectors, the Micro-D offers a choice of shielded wire-to-board (MDSM) or unshielded (MDS).

Stamped crimp snap contacts are supplied on reels for fast hand or semi-automatic crimping. Shielded cable connector kits contain jackscrews, hoods and integral shield cans, eliminating the need for optional accessories or expensive overmolding.

Shielded printed circuit board connectors are supplied with snap-in boardlocks, simplifying assembly and providing a grounding path to the board.



When shielding is not required, the MDS all-plastic provides a convenient connector for internal cabling.

For MDS/MDSM assembly instructions, refer to Manual No. MY-1/190.

Specifications

MATERIALS AND FINISHES

Insulators:	Thermoplastic, UL 94V-0 rated
Contacts:	Copper alloy, duplex plated gold engaging end, tin/lead termination area
Hardware:	Copper Alloy, nickel-plated
Shield and cover:	Steel, tin plated
Hood:	Thermoplastic, UL 94V-0 rated
Backshells:	Thermoplastic, UL 94V-0 rated
Jackscrews:	Copper alloy, nickel-plated

ELECTRICAL DATA

Current Rating:	1A/25°C; .7A/70°C.
Voltage Rating:	350 V.A.C.
Contact Resistance:	20 milliohms max.
Insulation Resistance:	5000 megohms min.
Operating Temperature:	-55/+125°C
Shielding Effectiveness:	70 dB

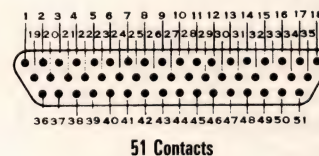
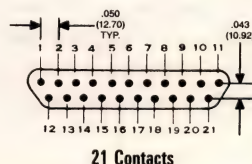
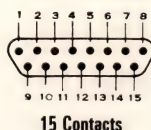
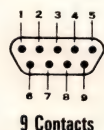
MECHANICAL CHARACTERISTICS

Wire Accommodation:	26-28 AWG
Contact Spacing:	.050"

Layouts

(Face View of Pin Insert – Use Reverse Order for Socket Side)

Standard

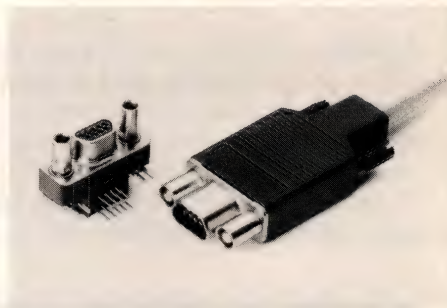
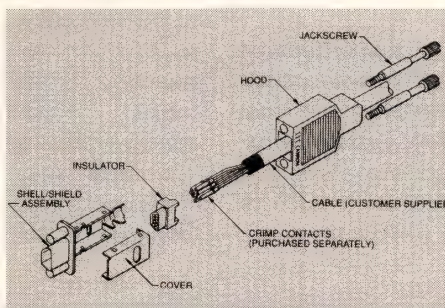


MDSM

The MDSM is the industry's smallest D-type connector for shielded I/O wire-to-board applications.

Featuring an integral snap-together shield can and stamped contacts, the MDSM is available in three layouts: 9, 15, and 25.

- .050" pitch for space-saving applications
- Crimp contacts supplied on reels for fast hand or semi-automatic termination
- AWG 26–28 wire accommodation
- Cable connector supplied as a complete kit including shield, hood and jackscrews
- Integral boardlocks for fast PCB connector installation



ITT Cannon

D Subminiature Products • 1851 E. Deere Ave, P.O. Box 35000, Santa Ana, CA 92705-6500 • (714) 261-5300 • FAX (714) 757-8324

Filter Modules & Isolation Transformers

FEATURES

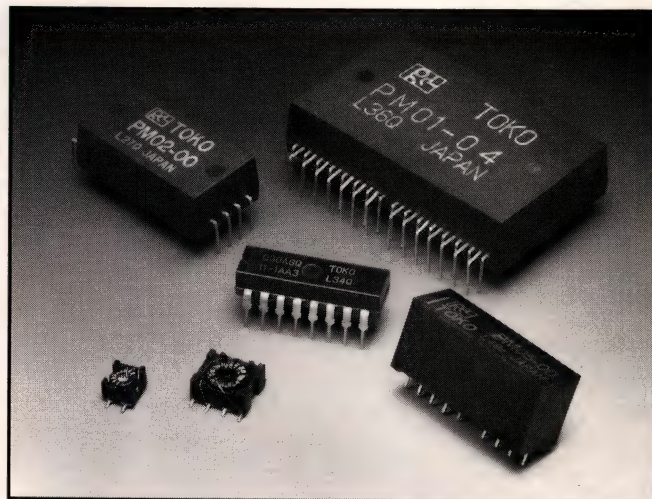
- Available with built-in common mode choke eliminates impedance-matching guesswork
- Experienced filter design provides low ripple, sharp cut-off
- Strong common mode rejection diminishes jitter and the influence of external noise
- Good isolation - provides resistance of up to 2000V RMS for 1 minute
- Crosstalk surpassing the IEEE 802.3 standard insures the integrity of your data
- Built-in resistors also available to further reduce circuit design calculations and hassles
- SIP, DIP, and QUAD versions available

DESCRIPTION

The twisted pair cable side of a transceiver requires external transmit and receive low pass filters, isolation transformers, and pre-distortion resistors. The filters' main purpose is the removal of high-frequency components from the data signal without affecting the inband frequencies (1-10 MHz). The high-frequency components can create electromagnetic interference (EMI) above the levels permitted by the FCC regulations. The transmitter sends preequalized data through the transmit filters onto the twisted pair medium. The transmit filter smooths the edges of the signal before passing it onto the twisted pair cable. Likewise, the receiver accepts and reads the data that has come through the external receiver filter.

The 10BASE-T filter modules provide the necessary interface between the transceiver IC and twisted pair cable. They are manufactured to a high level of quality that meets and exceeds the IEEE 802.3 requirements in every regard. They are designed to ensure minimum inband loss, ripple, and distortion while providing maximum attenuation of frequencies above 30 MHz with appropriate roll-off in the transition band.

Available in single-circuit design with a single-transmit circuit and a single-receive circuit or, a four-transceiver design with four individual transmit circuits and four individual receive circuits. The transformers supply proper signal coupling while maintaining the required 2000 Vrms isolation. Their design also includes optional added benefits such as built-in common mode choke and resistor network, where



COMPATIBLE TRANSCEIVER ICs

IC	Manufacturer
Am79C98	AMD*
Am79C980	AMD*
83902	National Semiconductor*
T7220	AT&T*
LXT902	Level One
82506	Intel
MB86962	Fujitsu

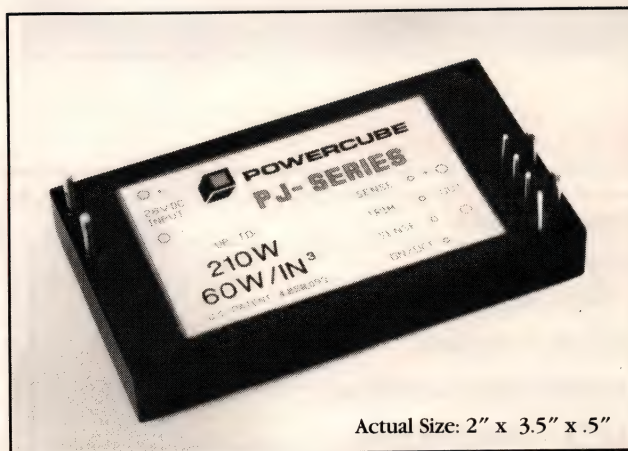
*Call for details on latest versions.

desired. They are also available without the resistor circuits for applications where you want more freedom in pre-distortion design and for custom design transceiver.

The common mode choke is necessary to reject the common mode radio frequency and electromagnetic interference picked up by the unshielded twisted pair cable. It provides 1,000 VDC isolation between the windings. The common mode choke has four windings, each connected with proper polarity, in series with the transmit and receive twisted pair cables. The balance of the choke is extremely important in providing the proper noise cancellation while passing on the differential signal unaffected. Having this vital common mode choke built in makes the circuit design process easier for most designers.

60W/IN³

210 Watts



Actual Size: 2" x 3.5" x .5"

The Size of a Standard Business Card!

From Powercube's commitment to excellence comes a new series of converters that sets the standard for all others to be compared. Through the use of patented integrated magnetics and sophisticated control circuitry, the PJ converter line offers the highest performance, highest reliability, and highest power density of any converter in the world!

Designed to Meet or Exceed

- MIL-STD-704
- MIL-STD-454L
- MIL-STD-461
- MIL-STD-810E
- MIL-HDBK-217E
- NAVSO P-3641
- NAVMAT P-4855-1A



PJ Series DC-DC Converters

Features

- HIGH POWER DENSITY
- Maximum Efficiency up to 88%
- Remote Sense
- Remote Shutdown
- External Trim
- Current Limit Protection
- Active OVP
- Parallelable
- MTBF > 1,000,000 Hours
- -55°C to +100°C Operation
- 50V Input Transient Tolerance
- Outputs 5, 12, 15, 24, & 28VDC
- MIL-S-19500 JANTX & 883C (available)
- Series Operation (consult factory)

Eight Suburban Park Drive, Billerica, Massachusetts 01821
Phone: (508) 667-9500 • Fax: (508) 667-6280
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PJ Series DC to DC Converter

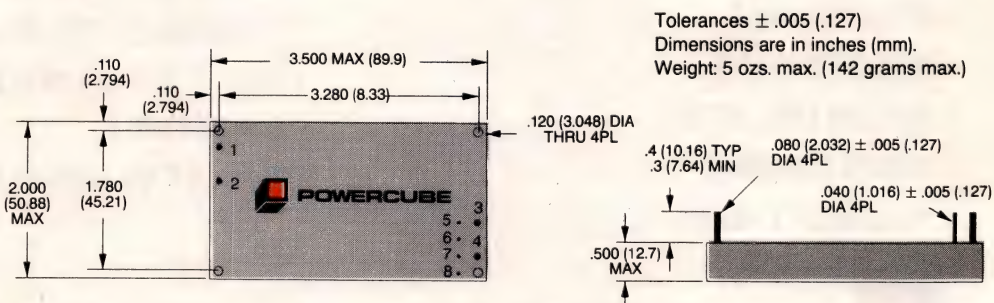
Specifications

PART NUMBER	28PJ5-110	28PJ12-200	28PJ15-200	28PJ24-210	28PJ28-210
INPUT VOLTAGE (See Output Power/Current)					
OUTPUT VOLTAGE	5V	12V	15V	24V	28V
OVERVOLTAGE SETTING (TYP)	6.9V	14.5V	17.5V	28.5V	33.5V
OUTPUT POWER (MAX)					
(22-34Vin +85 °C Max Base)	110W	200W	200W	210W	210W
(20-36Vin +85 °C Max Base)	100W	180W	180W	180W	180W
(20-34Vin +100 °C Max Base)	75W	140W	140W	140W	140W
OUTPUT CURRENT (MAX)					
(22-34Vin +85 °C Max Base)	22.0A	16.7A	13.4A	8.8A	7.5A
(20-36Vin +85 °C Max Base)	20.0A	15.0A	12.0A	7.5A	6.4A
(20-34Vin +100 °C Max Base)	15.0A	11.7A	9.4A	5.9A	5.0A
INITIAL SETTING (MAX)	±1%	±1%	±1%	±1%	±1%
TRIM RANGE	±10%	±10%	±10%	±10%	±10%
LINE REGULATION (MAX)	0.2%	0.2%	0.2%	0.2%	0.2%
LOAD REGULATION (MAX)	0.2%	0.2%	0.2%	0.2%	0.2%
TEMP. STABILITY (MAX)	0.008%/°C	0.008%/°C	0.008%/°C	0.008%/°C	0.008%/°C
EFFICIENCY (28Vin, FL) (TYP)	80%	84%	85%	86%	87%
RIPPLE & NOISE (20 MHz BW) (MAX)	60mV p-p	80mV p-p	80mV p-p	80mV p-p	80mV p-p
TRANSIENT RESPONSE (TYP) (25% Load Change)	150mV/ 300μS	250mV/ 500μS	250mV/ 500μS	500mV/ 500μS	500mV/ 500μS

For more information contact our sales office at (508) 667-9500.

Mechanical

PIN	FUNCTION
1	INPUT
2	INPUT RTN
3	OUTPUT
4	OUTPUT RTN
5	REM. SENSE +
6	EXTERNAL TRIM
7	REM. SENSE -
8	SHUTDOWN



POWERCUBE

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New Product Bulletin:

Dual Twinax/Triax Self-Normalizing Patch Jack With TRB Input Receptacles

J74 Series

J74T-R: Terminated
J74MST-R: Monitor-Terminated
(Two models shown)

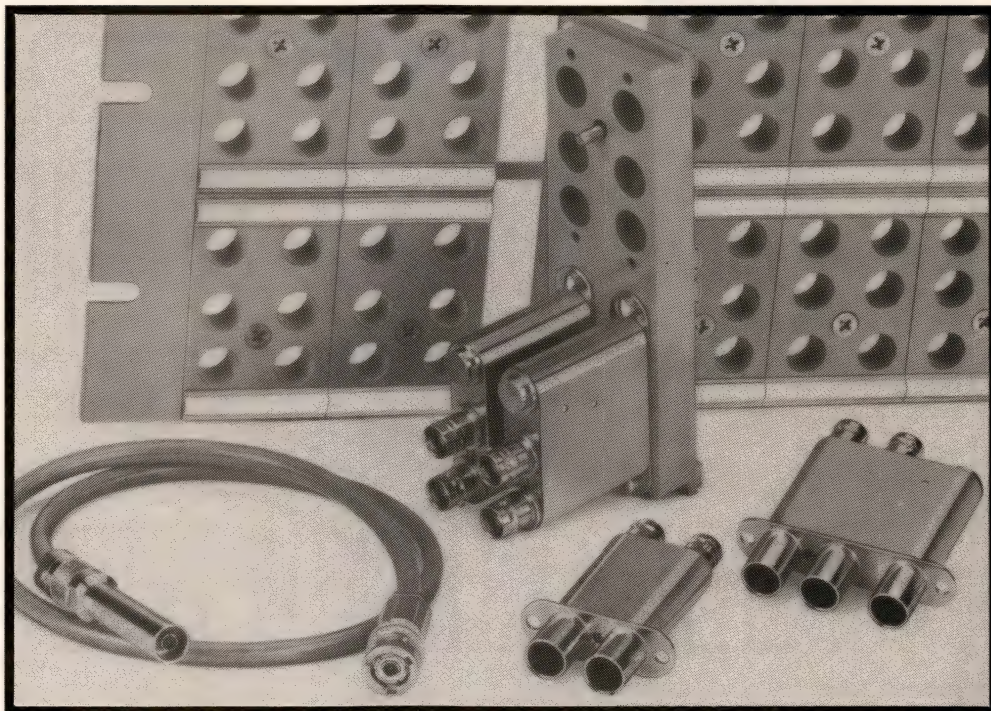
The J74 Series of connectors are dual twinax/triax jacks which automatically provide a normal-through signal path without the use of looping plugs or patch cords. The normalizing switch contacts utilize a unique self-wiping action for positive contact.

J74T-R (Terminated): Provides a resistive load to the unused side (Plugging into the source side automatically terminates the load side. Insertion into the load side automatically terminates the source side).

J74MST-R (Monitor-Terminated): Plugging into the source side provides a resistive load to the monitored side (Insertion into the load side monitors the normal-through signal).

Patent Pending

Application Notes:



Trompeter's J74 family of dual twinax/triax self-normalizing jacks includes jacks, plugs, looping plugs, monitor plugs, panels, patch cords and cable assemblies to provide matching components of twinax/triax connectors and cable for improving the transmission capabilities and interference rejection of data transmission systems. J74 Series of dual twinax/triax self-normalizing jacks are used in **Mil-aero** and **Commercial 78Ω/124Ω applications** where signals are protected from extraneous noise through non-signal-carrying shielding. Interfacing connectors must provide contact surfaces isolated from each other and from their outer shields. Trompeter components will meet or exceed **MIL-STD-1553B** ground support/check-out requirements. **MIL-STD-1553B** addresses twinax applications for computerized/multiplexed digital data distribution systems servicing the many functions of Command, Control, Communications and Intelligence (C3I) which was originally designed for military aircraft. **78Ω twinax/triax cable** is used to provide the transmitted digital information with the needed protection from magnetic, electro-static and nuclear electromagnetic pulse (NEMP) interference. Complete shielding along the transmission path must be maintained. MIL-STD-1553B applications are found in **naval surface ships** and in many military/commercial ground applications such as **telemetry, radar, satellite signal, data network, and perimeter security** for airports, armories, and other government installations.

Features:

Same size as our J14 Normal-Through coax patch jack.

Self-wiping, Self-normalizing switch with gold plated beryllium-copper blades.

All metallic parts are machined/formed/die cast to extremely close tolerances

Heat treated beryllium-copper female center socket contact with 50 millionths inch gold plating.

Connector bodies are made of top quality brass with a bright nickel-plated, non-tarnish finish. (Standard)

Dielectrics are made of machined Teflon™.

Benefits:

Up to **20** jacks on a 3.5" x 19" panel.
Up to **40** jacks on a 5.25" x 19" panel.
Replace/mix twinax/coax patching.

Positive electrical contact for over **30 thousand cycles**

Better intermateability improves EMI/RFI suppression and reduces signal loss.

Superior spring properties maintains contact resilience. Positive electrical contact over thousands of cycles.

Resists tarnishing and the associated reduction of conductivity.

Superior dielectric properties and heat resistance.

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I | N | S | T | R | U | M | E | N | T | S

USING RELAYS TO SWITCH ANALOG SIGNALS IS NEITHER SILLY NOR TRIVIAL

DAN STRASSBERG, Technical Editor

Choosing relays for switching analog signals is not necessarily an act of stupidity or masochism, but failing to take the subject of signal switching seriously can be a costly mistake.

EVERYBODY (WELL, EVERY *EE*) KNOWS that switching analog signals with relays requires little talent and less thought. The field is a technological backwater; the only engineers who might even consider working in it are those who have finally come to grips with their technical inadequacy . . . ones who know that their next career move will have to be to flipping hamburgers. The problem is, the field's reputation is undeserved; these widely held beliefs are dead wrong.

In fact, like just about everything else in electrical engineering that the conventional wisdom holds is "a piece of cake," relay signal switching is filled with traps for the unwary. Those who fail to appreciate the potential problems and to learn how to prevent them are doomed—needlessly—to spend many



hours in a frantic problem-solving crisis mode.

Relays' disadvantages are well known: Because they are devices whose operation depends on the movement of parts, they exhibit finite life expectancy; most exhibit contact bounce; compared with many solid-state alternatives, they are larger; their performance is more likely to suffer degradation from shock and vibration; and they usually consume more power.

Some types of relays are position sensitive, which renders them unsuitable for portable equipment and even causes headaches in packaging stationary units. (Few users will accept a system that stops working altogether when positioned to allow access for troubleshooting.) On average,

VXIbus modules are becoming increasingly important in the switching-systems market. These B-size units from Hewlett-Packard include several matrices and a medium-current, multipole form-C switch.

relays are more expensive than solid-state switches and despite automated manufacturing, their prices will not decline as rapidly over time.

Nevertheless, if you think that the way to avoid relays' problems is always to steer a wide berth

around the devices, you've fallen into the first of the field's many traps. Savvy designers have learned that, too often, the mindless application of cures of this sort cause pain far worse than that produced by the original illness.

Yes, there are solid-state alterna-

tives to relays. There are even devices that provide the isolation between the control and signal paths that relays offer (see **box**, "The optoFET alternative"). And though solid-state devices have been able to take over many signal-switching tasks that, in years past, were the exclu-

The optoFET alternative

If you feel that the disadvantages of relays are so great that you must use solid-state switching, but you want to buy system-level or subsystem-level switching products (as opposed to designing your own switching system at the component level), you will find your options somewhat limited. Although there are some system-level solid-state switching products among the offerings of the system and subsystem vendors listed in this article, the majority of the products use relays.

Articles in EDN, such as **Ref 3**, have provided a great deal of useful information on selecting solid-state switching devices for component-level designs, but have not provided much information on the one type of solid-state device that, for analog-switching, is most like a relay. That type of device is commonly called an optoFET isolator.

Most optoFETs appear to be what the name implies—a combination of an LED or LED array and one or more MOSFET switches, although, instead of real MOSFETs, some devices use specialized ICs that behave as if they were MOSFETs. Like relays and more common

types of optoisolators, but unlike FET switches that don't include LEDs, optoFETs provide true ohmic isolation between their control and "switch" terminals. Many units offer breakdown voltages in the thousands of volts between these two sets of terminals. Like many nonisolated FET switches, but unlike conventional optoisolators, optoFETs in normal operation have highly linear on-state resistance measured between their switch terminals.

Good form

OptoFETs are available as form-A (normally open) and form-B (normally closed) devices. You can obtain single packages that mix the two types and incorporate timing circuits to create form-C (single-pole, double-throw, break-before-make) contacts. You can also obtain packages that incorporate several switch elements of one type driven by a single LED array (in other words, a multipole configuration), and packages that contain several independent switch elements of one type, each driven by its own array.

Like their nonisolated counterparts, optoFETs have no contacts (hence, no contact bounce) and offer performance that, though more than adequate for many applications, falls short of that of relays in areas such as on resistance, breakdown voltage, and off-state leakage. Although optoFETs' leakage disqualifies them for most high-impedance measurements and capacitor measurements, many optoFET specs are quite impressive.

OptoFETs' maximum specs for on-resistance in normal operation range from a few hundred ohms to a few ohms; some of the low on-resistance units can carry hundreds of mA continuously. Breakdown ratings across open switch elements range from tens of volts to, more commonly, several hundred volts. Maximum off-state leakage for most devices is less than 1 μ A when you impress a voltage near the breakdown limit across a pair of open "contacts." The "coil" power you must apply to actuate most optoFETs is less than 30 mW (20 mA at 1.5V). And though most optoFETs probably exhibit offset voltages below 1 μ V, a very respectable figure, you will be hard pressed to find a unit whose data sheet guarantees such a specification.

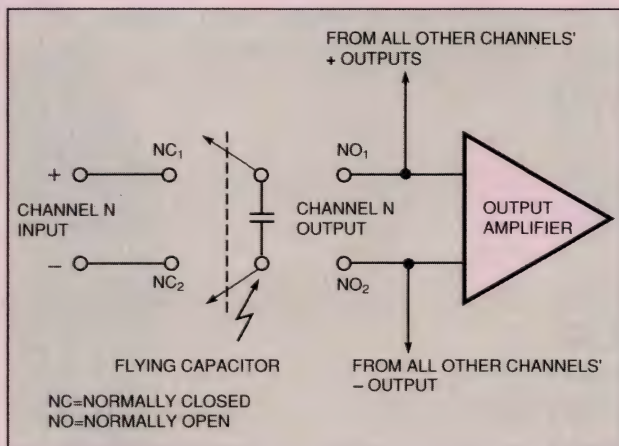


Fig A—The basic flying-capacitor multiplex switch consists of a 2-pole, form-C relay, with the flying capacitor connected to the common point of the two relay poles. Each channel's input signal connects to the channel's pair of normally closed contacts. All channels' normally open contacts connect together and to the inputs of the common (output) amplifier.

sive province of relays, the solid-state relays with which you are probably most familiar are not suited to error-free switching of analog signals. Indeed, the term "error-free" suggests why so many relay signal-switching problems are anything but trivial.

For sound technical reasons, relays continue to be mainstays in switching four classes of analog signals

- low-level (and usually low-frequency) signals such as transducer outputs (thermocouple outputs are a good example)
- extremely low currents and

other signals derived from high-impedance circuits

- RF, video, and high-frequency signals, like those found in broadband communication systems
- high-voltage and high-current signals.

Not surprisingly, although optoFETs' switching speeds are faster than those of most types of relays, the solid-state devices' turn-on and turn-off times (each usually in the 2-msec area, but faster for some devices) are much slower than those of nonisolated solid-state switches.

A feature offered in many optoFETs but not often found in relays is limiting of the "contact" current. Building a current limiter into a switch not only can safeguard the switch and the circuits that surround it when a circuit element in series with the switch shorts out, it can help the equipment that uses the switch to meet electromagnetic-interference specifications. However, the current limiting built into optoFET isolators' switches will not necessarily safeguard the devices from damage under conditions that relays can survive.

In small packages

Packaging of optoFETs is, at least externally, unremarkable. Six- and 8-pin mini-DIP packages still dominate, although vendors have been introducing surface-mount packages. Pricing is consistent with that of more conventional types of optoisolators; in OEM quantities, optoFETs generally cost between \$1 and \$3 each for single-pole, single-throw devices without current limiting.

To date, optoFET applications comprise what is decidedly a niche market. Nevertheless, at least five companies supply the devices, including two very sizable firms, AT&T Microelectronics and Hewlett-Packard. Perhaps optoFETs' still largely untapped potential to replace relays in the several billion analog subscriber-line circuits in telephone central offices around the world is what attracted this rather large vendor contingent.

Aside from uses in telephone, optoFETs will perform most signal-switching functions that require isolation between the control and signal terminals; for example, those in which the switches must handle signals superimposed on large common-mode voltages.

Flying-capacitor multiplexers are one such application. The basic flying-capacitor multiplex switch (**Fig A**) consists of a 2-pole, form-C relay, with the flying capacitor connected to the common points of the two

relay poles. Each input signal connects to its channel's pair of normally closed contacts. Each channel's pair of normally open contacts connects to the corresponding points of all other channels and to the input terminals of the common (output) amplifier.

To sample any channel's input, you energize that channel's relay (and only that relay), thereby connecting the selected channel's capacitor to the input terminals of the amplifier. Note that, even though the differential input signals can be superimposed on large common-mode voltages (limited by the breakdown voltage across open switch contacts), no large common-mode signal appears at the amplifier input.

These multiplexers typify applications where you must not blindly substitute solid-state switches for relays. In the FET version, the switch on-resistance, which can be as much as 1000× that of a mercury-wetted reed relay, can increase the charge time of the flying capacitor. If the input signal changes rapidly and you sample it frequently, errors that would not occur in the relay version of the circuit can result. Similarly, if a number of channels experience high common-mode voltages of the same polarity, the leakage of switches in the off state can cause errors that would not arise in a relay-based system.

On the other hand, with slowly varying signals—the most likely inputs for flying-capacitor circuits—the FET switches' on-resistance rarely causes problems. And though the common-mode-induced leakage-current stands a better chance of producing significant errors than on-resistance does, in most situations, the effects will not be as troublesome as you might expect. For one thing, if each channel's switches are reasonably well matched for leakage, the leakage effects will produce a common-mode error that a differential output amplifier will attenuate. Secondly, if you make sure that the common-mode voltage across open switches is well below the switches' breakdown ratings, the leakage will be less than the maximum specified.

Accurate switching of such signals demands varying combinations of characteristics that relays, and sometimes *only* relays, possess: low offset voltages that are nearly independent of temperature (although in some cases, relays' higher power consumption causes temperature rises that decrease this advantage); low on-resistance; high off-resistance; near-zero off-state leakage current; almost total ohmic isolation between control and signal paths (extremely good capacitive isolation, too); high breakdown voltage; and the ability to survive—without damage—spikes and surges that contain enough energy to destroy solid-state switching devices.

Relays come in a variety of constructions. These different types have characteristics that suit them for particular purposes. **Table 1** is a summary of some of the types. One type missing from the table is coaxial relays used in high-frequency applications.

Two basic topologies

From a topological viewpoint, signal-switching circuits fall into two main categories: multiplexers or scanners (**Fig 1**) and matrices (**Fig 2**). Multiplexers and scanners connect many signal sources, one at a time, to a single load (sometimes a measuring unit, sometimes a unit under test). Multiplexers can also connect one signal source to many loads, one load at a time. Matrices, often used in automatic-test sys-



All switching systems aren't large, nor do all of them require you to use the system computer for control. Keithley's 7001 is a half-rack unit that accepts plug-in modules and sports a front panel that affords full control—a handy feature during checkout and debugging.

tems, are 2 dimensional. They can connect several sources to several loads in different combinations.

Remember, though, that circuit topology in a somewhat different sense can have a profound effect on the circuit performance. For example, in RF switching circuits, lack of care in connecting termination resistors can easily produce improperly terminated stubs, causing reflections that distort signals.

In low-level measurement circuits, lack of care in grounding can produce ground loops that superimpose line-frequency-related "noise" on your signals. Inadequate care in grounding can also cause I-R drops in conductors that you thought would

not carry current. The result can be unstable readings that depend on conditions in parts of your system you were sure couldn't possibly influence the measurement you're trying to make at the moment.

The problems encountered most frequently by system designers who use relay switching result from

- failing to understand the application requirements in sufficient detail
- selecting switching products that aren't completely appropriate to the application
- doing something in the system design that defeats the inherent advantages of the switching products selected.

Approaching the selection and configuration of the switching system as if the job were a "no-brainer" just about guarantees that you will make at least one of these mistakes. **Ref 1**, an indexed, illustrated, soft-cover book of about 200 8.5 × 11-in. pages is a good source of additional information and caveats, particularly about switching relatively low-frequency and high-impedance signals with high accuracy.

An example of an area where relays excel and face no imminent

Table 1—Major attributes of several relay types

Relay type	Isolation (Ω) ¹	Speed (msec) ²	Power (VA)	Life at rated load (cycles)
Electromechanical	10^7 to 10^{10}	20 to 100	10 to 100	10^7
Contactors	10^6 to 10^9	100 to 250	100 to 4k	10^5
Dry Reed	10^9 to 10^{14}	5 to 15	10 to 50	10^7
Mercury Wetted Reed	10^8 to 10^{12}	5 to 10	10 to 100	10^{10}

NOTES: ¹From coil to contacts, from pole to pole, or across open contacts.

²For a complete off-on-off cycle.

Courtesy Keithley Instruments Inc

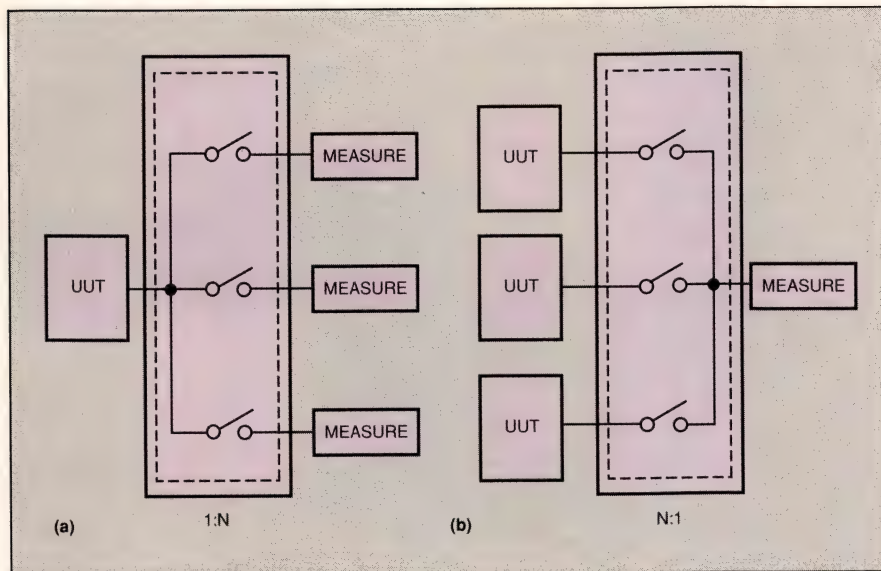


Fig 1—A multiplexer can connect one source (in this case, a unit under test (UUT)) to any one of several loads (in this case, N measuring instruments) as in (a), or it can connect one of several sources to one load (b). The multiplexer makes the connections in random or sequential order; a scanner is similar, but always makes the connections sequentially.

threat from solid-state switches is in low-current measurements—capacitor-leakage measurements, for example. When you measure currents in the picoampere or femtoampere region, opportunities for obtaining totally meaningless results without realizing that you have done so present themselves at every turn. Obviously, leakage can exist within the relays—across open contacts, from coil to contacts, and from pole to pole. As **Table 1** makes clear, leakage resistance varies by many orders of magnitude among different types of relays; dry-reed relays offer the lowest leakages.

Leakage can also exist on the pc boards that contain the relays and on the terminals where you make connections between the unit under test and the switching system. Dielectric absorption can occur here too, causing voltages to appear across circuit points whose capacitance you have already discharged by applying (and removing) a short circuit.

Because the measurement circuits have very high impedance levels, capacitive coupling to power

lines can introduce line-frequency-related “noise.” Similarly, if measurement circuits enclose any appreciable area, magnetic fields from nearby transformers, soldering

irons, and even line cords can introduce magnetic pickup.

To avoid problems in this realm, choose materials carefully to minimize leakage and dielectric absorption. Lay out wiring with care and use electrostatic shielding to minimize capacitive coupling. To reduce magnetic pickup, minimize wiring-loop areas, for example, by twisting pairs wherever possible. By supplying “shorted turns,” which carry currents creating fields that tend to cancel interfering magnetic fields, electrostatic shields can also reduce magnetic pickup. Nevertheless, moving wiring away from sources of interference is your best defense against magnetic pickup.

Using high-permeability materials for magnetic shielding is something that many designers attempt only in desperation. Shielding material is costly. Moreover, a magnetic shield should totally encircle the source of interference or the circuit you are trying to shield; meeting this geometric constraint can pose

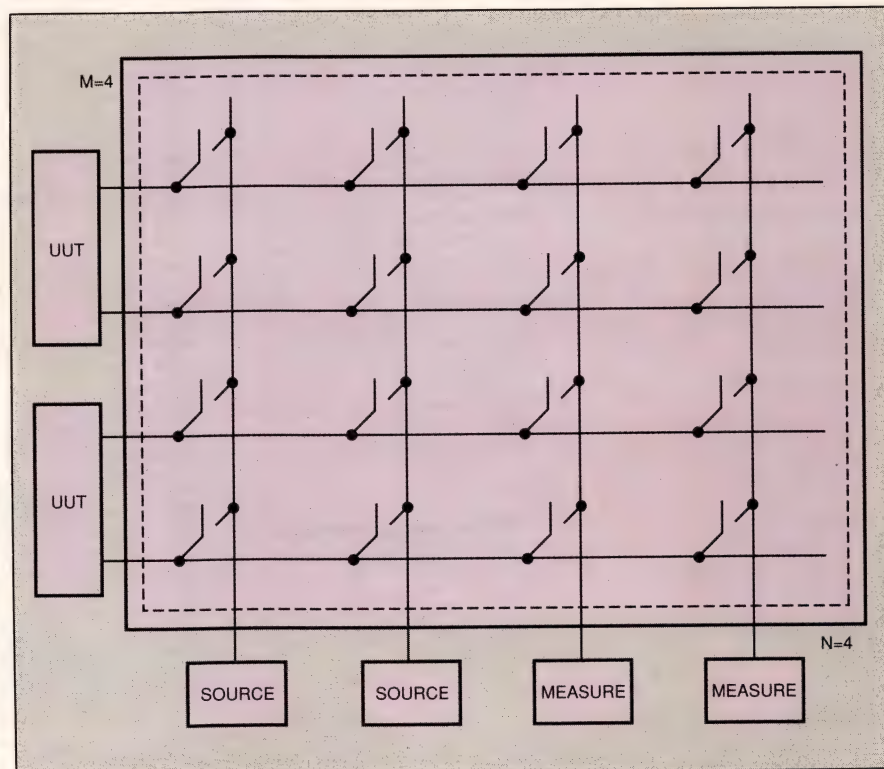


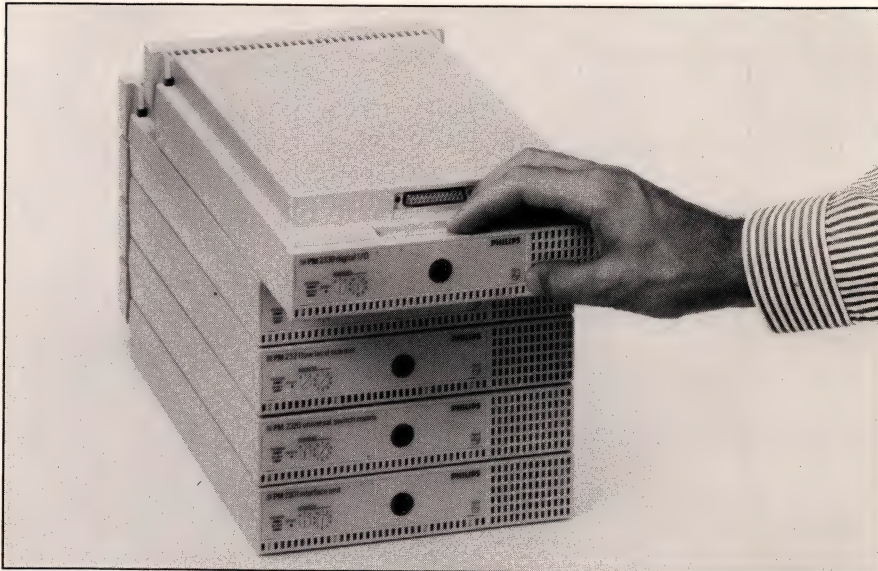
Fig 2—A matrix, such as this $M \times N$ configuration is more general than a multiplexer (in this case, $M = N = 4$). It can connect several sources to several loads in any combination.

INSTRUMENTS

intractable problems. Furthermore, magnetic shields often produce inconsistent results because the mechanical stresses of normal handling so easily alter their properties.

Most relay-switching systems are modular; you can configure them by selecting plug-in units. This construction lets you choose the particular switches and materials that best suit your application. Within the modules, the switching-system vendor will have taken the requisite care with circuit layout and component positioning.

Among your options are units that you can control via IEEE-488 and RS-232C. For applications that involve only measurements you can make with a DMM and where 10 to 20 channels are adequate, several vendors provide scanner options



Switching-system modularity takes many forms. The units of the Philips T&M/Fluke System 21/23 connect when you stack them. The family includes low-level, high-current, and RF switches. A master module, which interfaces to the IEEE-488 bus, contains a supply that powers the group of modules it controls.

For more information . . .

For more information on analog-signal-switching products such as those discussed in this article, circle the appropriate numbers on the Information Retrieval Service card or use EDN's Express Request service. When you contact any of the following manufacturers directly, please let them know you read about them in EDN. **Note:** The notation ^o following a company name denotes a supplier of optoFET switch devices; the notation ^s denotes a supplier of signal-switching systems or subsystems.

A D Data Systems Corp^s

770 Basket Rd
Webster, NY 14580
(800) 828-6489;
(716) 265-1600
FAX (716) 265-1689

Circle No. 650

AT&T Microelectronics^o

Dept 52A1040420
555 Union Blvd,
Allentown, PA 18103
(800) 372-2447
FAX (215) 778-4106

Circle No. 651

Coto Wabash^o

55 Dupont Dr
Providence, RI 02907
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FAX (401) 942-0920

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CP Clare Corp^o

107 Audubon Rd
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(617) 246-4000
FAX (617) 246-1356

Circle No. 653

Cytec Corp^s

2555 Baird Rd
Penfield, NY 14526
(800) 346-3117;
(716) 381-4740
FAX (716) 381-0475

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Hewlett-Packard Co.^s

Box 58059, MS 51L-SJ
Santa Clara, CA
(800) 452-4844

Circle No. 655

John Fluke Mfg Co Inc^s

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Everett, WA 98206
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Keithley Instruments Inc^s

28775 Aurora Rd
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Circle No. 657

NSD Corp^s

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Winnetka, CA 91306
(818) 700-9990
FAX (818) 700-8318

Circle No. 657

Philips Test and Measurement^s

Bldg TQIII-4
5600MD Eindhoven
The Netherlands
Phone local office

Circle No. 658

Precision Filters Inc^s

2400 Cherry St
Ithaca, NY 14850
(607) 277-3550
FAX (607) 277-4466

Circle No. 660

Prema Precision Electronics Inc^s

4650 Arrow Highway, Bldg E-5
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(714) 621-7292
FAX (714) 625-2098

Circle No. 661

Quality Technologies Corp^o

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Sunnyvale, CA 94026
(408) 720-1440
FAX (408) 720-0848
TLX 6731382

Circle No. 662

Racal-Dana Instruments Inc^s

Box C-19451
Irvine, CA 92713
(800) 722-3262;
(714) 859-8999
FAX (714) 859-2505
TLX 188715

Circle No. 663

Tektronix Inc^s

Box 1520
Pittsfield, MA 01202
(800) 426-2200

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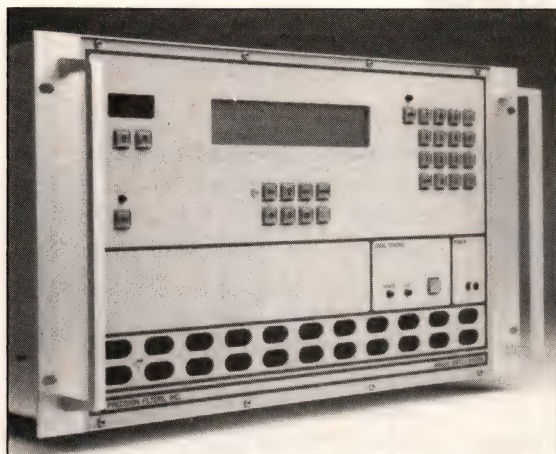
Note: Fluke distributes Philips T&M products in North America; Philips T&M distributes Fluke products in Europe.

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Some vendors' product lines are well suited to applications that involve thousands of points. Although Precision Filters' 4000 series is such a line, you can also use units such as this one to build economical systems with fewer than 100 points.

that plug into slots in their DMMs. Prema is one such vendor. A trend that seems to be taking the industry by storm is that of offering switching products as modules for the VXIbus. In fact, EDN's VXI product surveys (for instance, **Ref 2**) have consistently turned up more switching modules than any other kind of VXI product.

As you might expect from the great diversity of products, switching-system prices cover a broad range. Indeed, one vendor said that he's sold systems priced at \$250, \$25,000, and just about every price between. Although most vendor literature provides detailed module specifications and prices, you will probably conclude that you stand the best chance of obtaining the most economical system that offers the features and performance you want if you talk to one of the vendor's applications engineers and obtain a written quotation.

When you purchase switching products, remember that, regardless of how much attention the vendor pays to layout and construction, you're the one who controls the overall quality of the system you put together. That's why your knowledge and expertise and the effort you make to understand your requirements in detail are so important. Picking the wrong products or incorrectly executing details of the

portion of the system that surrounds the purchased units can result in performance much worse than you expected. Although switching system vendors' applications engineers stand ready to help you out of a jam, you make both your own job and theirs a lot easier by doing your homework. **EDN**

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1. Keithley Instruments Inc, *Switching Handbook, Second Edition*, December 1989.
2. Strassberg, Dan, "VXI source guide: Costly technology can save you money," *EDN*, October 10, 1991, pg 73.
3. Conner, Doug, "Analog switches and multiplexers," *EDN*, March 15, 1990, pg 130.

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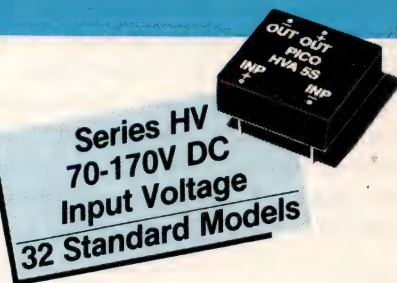
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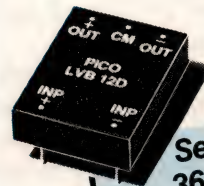
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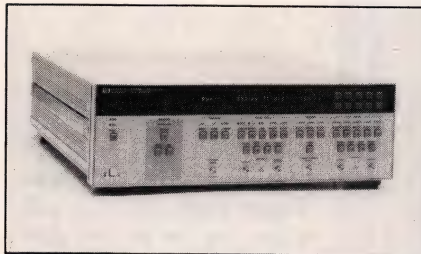
EDN July 20, 1992 • 125

Instruments

Generator places 60-psec rise-time pulses within 75 psec at 3 GHz

The 8133A pulse generator, whose output frequency extends from 33 MHz to 3 GHz, places its pulses with an error typically <75 psec (150 psec max) with respect to a trigger. You can vary the pulse delay with respect to the trigger from -5 to +15 nsec. The maximum jitter in this placement is 5-psec rms; the typical jitter is <2 psec rms.

The rise and fall times of the generator's square waves and 150-psec- to 10-nsec-wide pulses are 100 psec max—60 psec typ—measured from 10 to 90%. The generator pro-



duces pulses and square waves whose amplitudes into a 50 Ω load are 0.1 to 3V. You can obtain simultaneous normal- and inverted-polarity outputs. If you connect your 50 Ω load to ground, you can vary

the output offset from -2 to +4V.

This generator's optional second channel provides a 64-bit pattern memory. Or, instead of choosing a data generator, you can choose a second pulse channel, which can produce pseudorandom binary sequences.

You can control most of the unit's output from its panel. Price \$27,100 to \$45,900, depending on options. Delivery six weeks ARO.

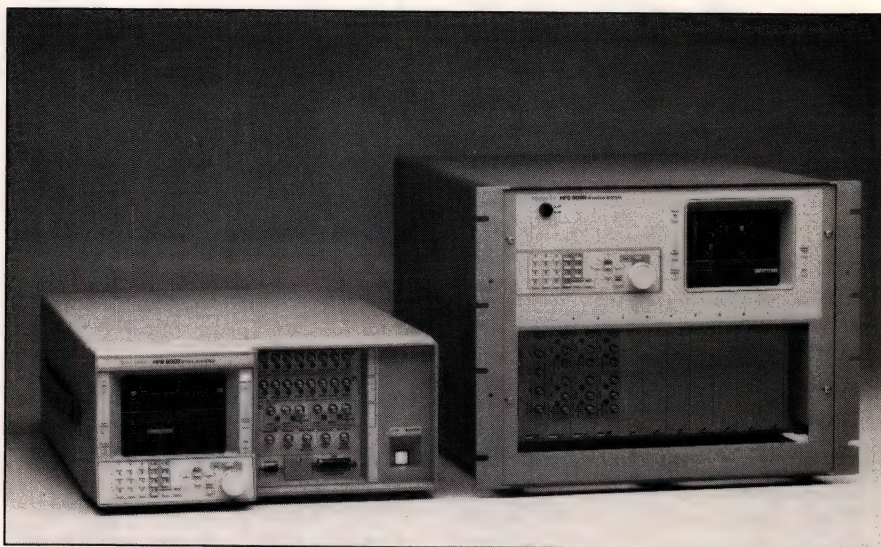
Hewlett-Packard Co, 19310 Pruneridge Ave, Cupertino, CA 95014. Phone (800) 752-0900. Circle No. 739

Modular unit combines functions of pulse and word generators

The HFS 9000-series modular data/time generators cost less and are easier to use than a set of separate word and pulse generators. A \$28,495 8-channel configuration of the instrument replaces a collection of word and pulse generators that would cost three times as much and occupy many times the 7 in. of rack space this instrument uses.

The user interface is a touch-sensitive monochrome CRT that displays timing diagrams and menus. The maker replaced nearly all of the analog functions of a pulse generator with their digital equivalents. Eliminating the analog circuits reduces interactions among controls.

The instrument produces signals at rates as fast as 630 Mbps per channel. Behind each channel is 64 kbits of pattern memory. The edge-position resolution is 5 psec. The generators can precisely and repeatedly simulate metastable states.



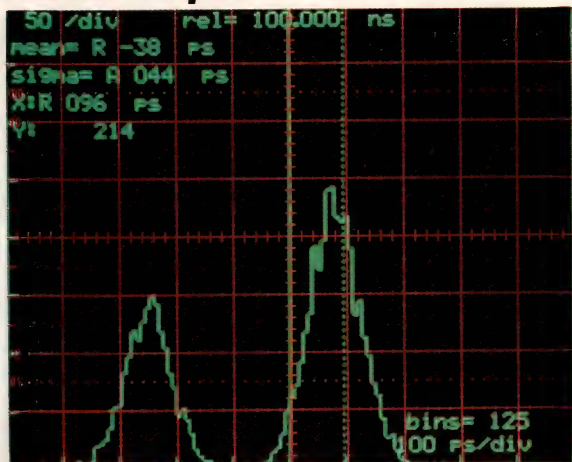
The modular system includes two generator units. An \$11,000 4-channel plug-in module offers fixed rise and fall times of <250 psec. A \$7900 4-channel plug-in module provides transition times that you can vary from 800 psec to 6 nsec. Tektronix offers two mainframes: a 3-slot (12-channel) unit that costs

\$12,695 and a 9-slot (36-channel) unit costing \$19,995. By using several mainframes, you can put together larger configurations having 640 or more channels. Delivery 8 to 12 weeks ARO.

Tektronix Inc, Box 1520, Pittsfield, MA 01202. Phone (800) 426-2200. Circle No. 740

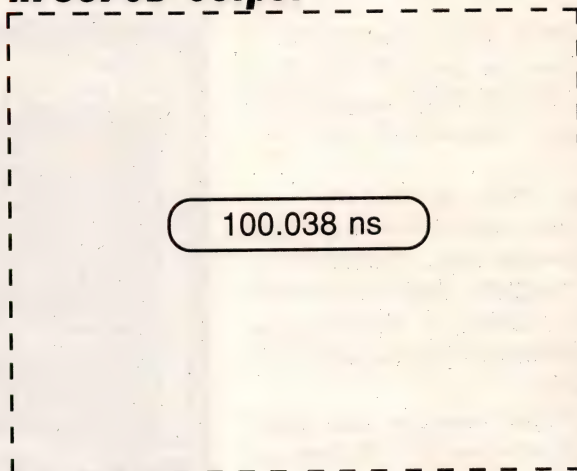
A picture is worth a thousand points in a time interval measurement.

SR620 Output



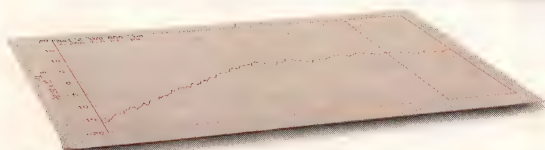
The SR620 brings graphic statistical analysis to time interval and frequency measurements. The SR620 shows you more than just the mean and standard deviation - multimode frequency distributions or systematic drift for example. Histograms or time variation plots are displayed on any X-Y oscilloscope, complete with Autoscale, Zoom, and Cursor functions. Hardcopy to plotters or printers is as easy as pushing a button.

HP5370B Output



Of course, the SR620 does everything else you'd expect from a high resolution universal counter, such as frequency, period, time interval, pulse width, rise / falltime, and phase measurements. The SR620 offers 25 ps single-shot time and 11 digit frequency resolution and complete statistical analysis, all for a fraction of the cost of comparable instruments.

For the whole picture, call SRS and ask about the SR620.



SR620

\$4500

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- GPIB and RS232 interfaces
- Optional oven timebase



STANFORD RESEARCH SYSTEMS

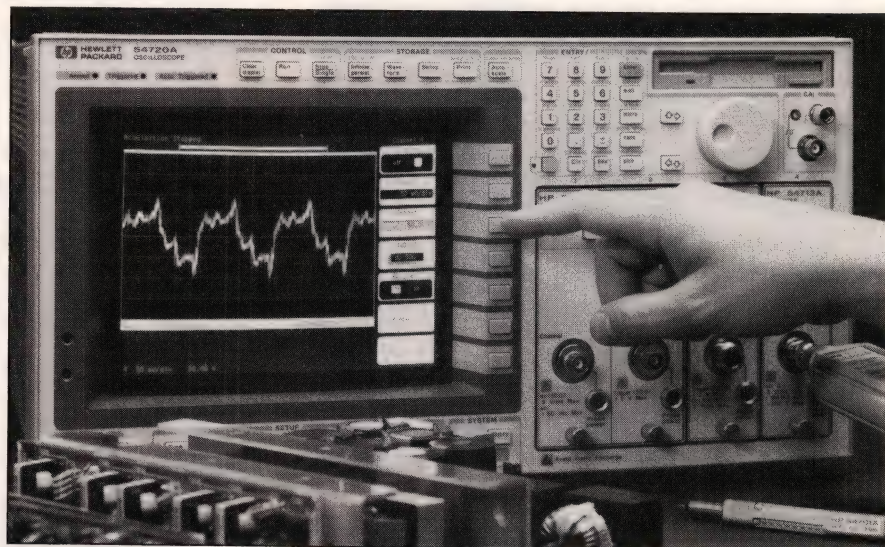
Modular scope takes 4G 8-bit samples/sec in real time on two channels

The 54720A DSO takes 4G 8-bit samples/sec on each of two channels; the 54710A DSO takes 2G 8-bit samples/sec on each of two channels.

Using DSP techniques, the scopes reconstruct waveforms from 4-sample/cycle data. This ratio limits the 54720A's single-shot bandwidth to 1 GHz. For repetitive signals, both scopes have a bandwidth of 1.5 GHz.

The scopes measure time intervals with an error of <30 psec and a resolution of less than 1 psec and exhibit timing jitter of <5-psec rms. They can trigger on glitches as narrow as 500 psec, yet produce less than 300- μ V rms noise.

At lower sampling rates, resolution improves: The scopes offer 9-bit resolution at 500 Msamples/sec and 12-bit resolution with averaging. The scopes have 32k words of memory on two chan-



nels and 16k words on four. They have high-resolution color displays.

The 54720A scope costs \$42,900, and the 54710A DSO costs \$29,900. Prices for plug-in modules range from \$2400 to \$4700, and a 2.5-GHz

active probe with power supply costs \$3500. Delivery 16 weeks ARO.

Hewlett-Packard Co, 19310 Pruneridge Ave, Cupertino, CA, 95014. Phone (800) 752-0900.

Circle No. 741

High-frequency digital scopes provide sequential or repetitive sampling

The TDS 640 has four channels, takes 2 Gsamples/sec/channel, and costs \$20,980 with four active probes. The instrument's display is high-resolution monochrome. The unit doesn't include a disk drive, stores 2 ksamples/channel, and comes in a fixed 4-channel configuration. A 2-channel version, the TDS 620, costs \$13,540 with two probes. Both scopes have a 0.5-GHz bandwidth for transient and repetitive phenomena. They do not use techniques to enhance their effective sampling rate when they acquire high-speed repetitive waveforms.



The TDS 820 is a 2-channel, sequential-sampling digital scope that has a 6-GHz repetitive-signal bandwidth (8-GHz optional) and 14-bit resolution. The instrument has a maximum sensitivity of 2 mV/div (1 mV/div in the 8-GHz version). The unit has a menu-driven interface.

A feature of the 6-GHz-band-

width scope that is unusual in sequential-sampling scopes is a delay line that lets you view pretrigger information. In scopes that offer equivalent-time sampling, pretrigger displays are normally found only in units that use random repetitive sampling, a technique that doesn't provide the bandwidth of sequential sampling.

TDS 820 \$19,100; delivery eight weeks ARO. Delivery for the TDS 620 and TDS 640 is six weeks ARO.

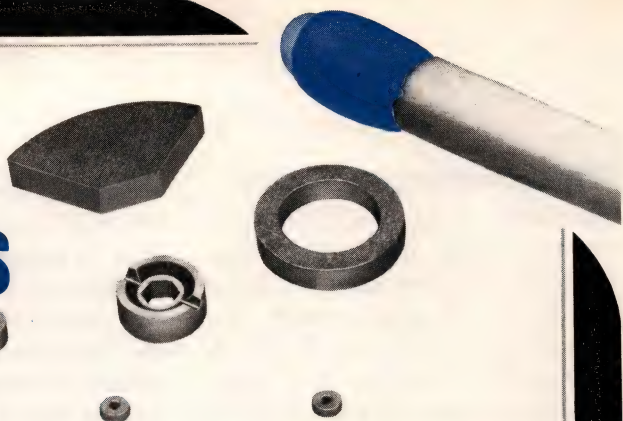
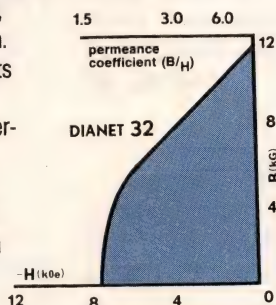
Tektronix Inc, Box 1520, Pittsfield, MA 01202. Phone (800) 426-2200.

Circle No. 748

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DM-28	27 to 29	10.5 to 11.0	5.0 to 7.0	> 5.00
DM-26	25 to 27	10.1 to 10.6	5.0 to 7.0	> 5.00
DM-24	23 to 25	9.7 to 10.2	6.0 to 8.0	> 6.00
DM-22	21 to 23	9.2 to 9.7	8.0 to 9.2	> 8.00
DM-20	19 to 21	8.7 to 9.2	8.5 to 9.2	> 8.50
DM-18	17 to 19	8.2 to 8.7	8.0 to 8.7	> 8.75
DM-16	15 to 17	7.7 to 8.2	7.5 to 8.2	> 9.00

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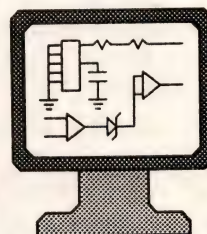
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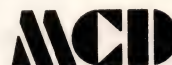
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EDN July 20, 1992 • 129

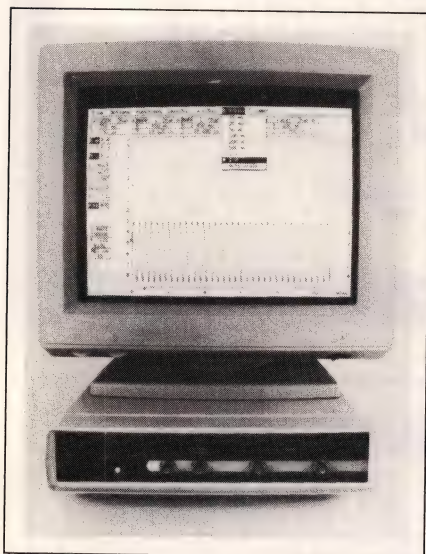
Instruments

EPROM Programmer For PCs

The ROM Master EPROM programmer plugs into a PC's backplane; a cable connects a 4-socket header to the programmer. The programmer handles EPROMs ranging from 16 kbits to 4 Mbits. Accompanying software handles common file formats. \$149.

Xeltek, 764 San Aleso Ave, Sunnyvale, CA 94086. Phone (408) 745-7974. FAX (408) 745-1401.

Circle No. 385



PC-Based FFT Spectrum Analyzer

The R380 PC- and Mac-compatible, FFT spectrum analyzer has two channels, each with 14-bit resolution. The analyzer connects to the computer's serial port. The unit features 85-dB dynamic range and a 100-kHz sample rate. Each channel has a 16k-word data buffer. \$1995.

Rapid Systems Inc, 403 N 34th St, Seattle, WA 98103. Phone (206) 547-8311. FAX (206) 548-0322. TLX 265017.

Circle No. 386

Data-Acquisition System

The SI 3535D data logger provides as many as 200 channels in a 19-in.-rack mainframe and 600 channels with an expansion chassis. The

mainframe includes a PC with a 640×200-pixel back-lit LCD running Windows 3.0-based software for setting up channels and controlling data collection. The mainframe also includes a 19-bit ADC and 10-module slot capacity for input channels or digital I/O. Other hardware includes battery backup and an IEEE-488 and RS-422 interface. From £7200.

Schlumberger Technologies, Victoria Rd, Farnborough GU14 7PW, UK. Phone 252-544433. FAX 252-543854.

Circle No. 387

VXI Virtual Instruments

The 7600 series of virtual instrument software combines with 3100 series single-slot C-size VXI modules to produce function and arbitrary-waveform generators, as well as make DMM, waveform, and spectrum analysis, and event recorder measurements. The virtual instruments operate within the 3538 modular test system running under control of the 7630 main operating system. Function generator 7625 (\$1850), and arbitrary generator 7611 (\$1850) use 30-kHz output module 3105 (\$5400). DMM 7605 (\$1195), waveform analyzer 7626 (\$1695), spectrum analyzer 7627 (\$3895), and event recorder 7624 (\$1295), all require 30-kHz input module 3005 (\$5900) or 5-channel charge amplifier 3008 (\$5500).

Brüel & Kjaer, 18 Naerum Hovedgade, DK-2850 Naerum, Denmark. Phone 4280-0500. FAX 4280-1405.

Circle No. 388

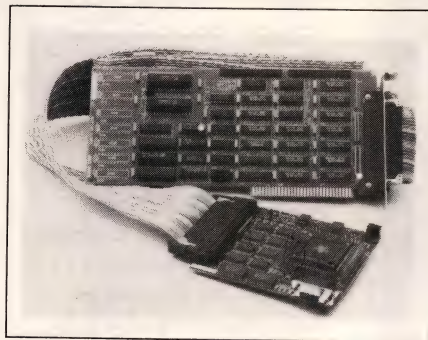
Temperature Controller

The model 3000, PuP II data logger can store 600 samples of two readings concurrently. The instrument accommodates all common thermocouples and can output readings directly to a printer. Stored information also includes time and date of each datum. The unit's blue dot-

matrix display can show readings and zoom in. The unit comes in a 1/4 DIN metal case. \$750. Delivery, four to six weeks ARO.

LFE/Instruments, 55 Green St, Clinton, MA 01510. Phone (508) 365-3400.

Circle No. 389



Microcontroller Emulator

The EMUL16/300 emulates 68HC16 and 68300 microcontrollers. The emulator comprises an IBM PC board, cable pod, and optional trace board. It works with all Motorola microcontrollers that use the "background-debug" mode. The emulator's software runs under Windows 3.0. EMUL16/300, \$1995; microcontroller pods, \$1995.

Nohau Corp, 51 E Campbell Ave, Campbell, CA 95008. Phone (408) 866-1820. FAX (408) 378-7869.

Circle No. 390

Impedance Signature PC-Board Tester

The T6000 is a tester for unpowered pc boards loaded with components. You can operate the tester from a PC using an RS-232C interface or as a stand-alone bench instrument. In operation, the tester checks a sequence of impedance signatures against a record of signatures taken from a working pc board. The instrument includes a 128-pin scanner for signature collection and testing. Using the scanner, you can sequentially test signatures on VLSI ICs directly or via a pc-board's I/O edge connections. Tests on a 40-pin IC

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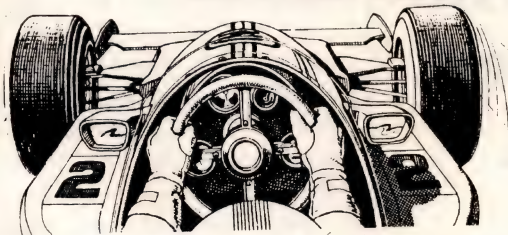
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CIRCLE NO. 105

EDN July 20, 1992 • 131

Instruments

take 10 sec. As a stand-alone instrument you can use the internal CRT display to compare waveforms from two assemblies simultaneously. £5750.

Polar Instruments, Garenne Park, St Sampson's, Guernsey, Channel Islands, UK. Phone 481-53081.

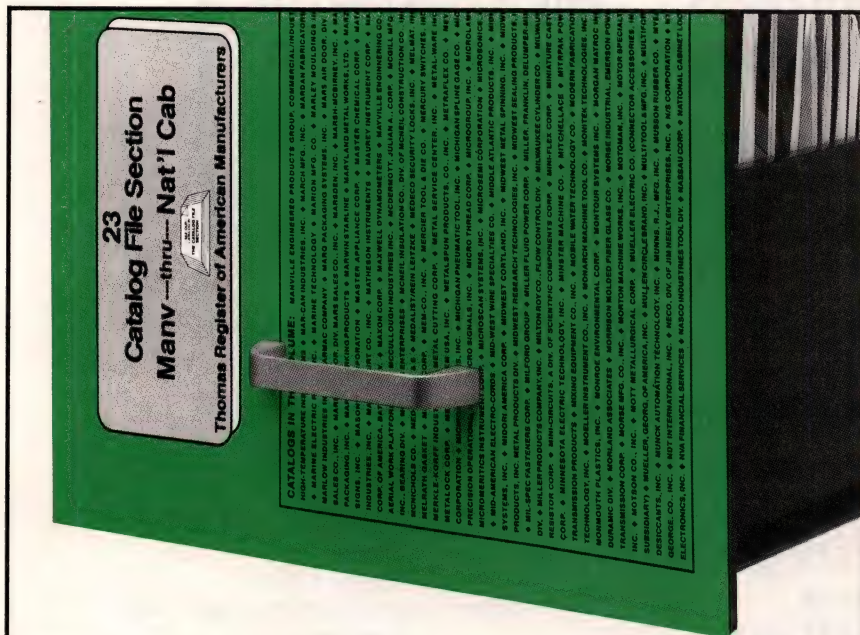
Circle No. 391

Embedded-Program Debugger

The IDS embedded-programming debugger includes a windowing software environment for common embedded- μ P assemblers and compilers and a target board in which to debug embedded programs. The software runs on PCs. Target μ Ps include the 8051 family, 68HC11

family, and Z80 family. The software and board can simulate I/O as well as execute common debugging and software-profiling functions. \$2435.

Cactus Logic Inc, 180 N Vinedo Ave, Pasadena, CA 91107. Phone (800) 847-1998; (818) 796-1773. FAX (818) 796-6011. Circle No. 392



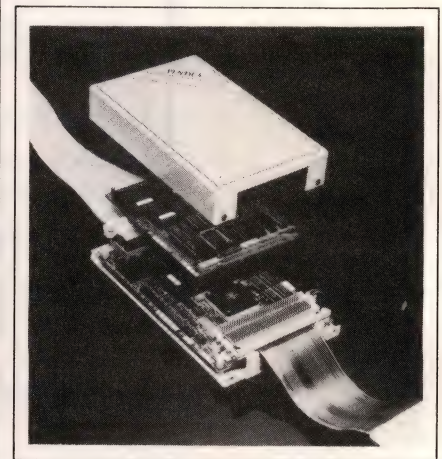
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68HC16Z1 Emulator

The MIMI-700 emulates the 68HC16Z1 microcontroller at full system speeds. The emulator has four 81-bit word recognizers that halt execution before the breakpoint instruction. The unit also has a 128-bit \times 8k-word trace buffer and 48-bit timestamping. The unit can accommodate 2 Mbytes of emulation memory max. \$14,659 with 256 kbytes of emulation memory.

Pentica Systems Inc, 19A Crosby Dr, Bedford, MA 01730. Phone (617) 275-4419. Circle No. 393

Differential Oscilloscope Probe

The model ADF15 differential oscilloscope probe has a 15-MHz bandwidth and switchable $\times 20/\times 200$ attenuation. You can power the unit with batteries or an external supply. The unit measures $6.5 \times 2.5 \times 0.75$ in. and weighs 10 oz. \$375.

Test Probes Inc, 9178 Brown Deer Rd, San Diego, CA 92121. Phone (619) 535-9292. Circle No. 394

CIRCLE NO. 77



EDN's 1992 Innovation/Innovator of the Year Awards Competition is in its final and most important stage — reader voting. In May, EDN's editors were swamped with nominations, and now its technical editors are hard at work choosing the finalists in each of the nine categories.

In August, we'll unveil the list of finalists in *EDN's Special August 20th Innovation Ballot Supplement*. Each finalist will be the subject of a short feature story that will help you make your final decision on who to vote for, and provide you with interesting information on what's new in the world of electronics.

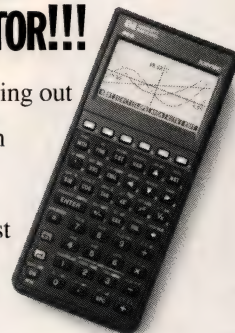
So keep your eyes open for *EDN's Special Innovation Ballot Supplement* which accompanies EDN's regular August 20th issue and make sure to get your ballots in. EDN is counting on your expertise as an engineering professional to choose the industry's best.

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Supplement you can qualify to win a **HP 48S Scientific Calculator**. Valued at \$250, this Hewlett-Packard calculator is the first calculator that enters equations in textbook style and provides interactive calculator graphics. But — just like the innovation finalists — only a select few will win so make sure to send in your ballot! By sending in your ballot, you are automatically entered in a random drawing to be held on September 30th. You will be notified by mail if you are a winner.

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Vr4000PC (64-bit)

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Vr series**Vr3010A** (32-bit FPU)

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Vr3000A (32-bit CPU)

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- 33MHz: 175-pin PGA/Plastic PGA
- 40MHz: 175-pin PGA

Vr3600A (32-bit CPU + FPU)

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Pragmatic Instruments Inc,
7313 Carroll Rd, San Diego, CA
92121. Phone (619) 271-6770. FAX
(619) 271-9567. **Circle No. 395**

I²C/ACCESS.bus Monitor

The MIIC-101 is a stand-alone, handheld troubleshooting tool for the I²C Philips serial bus and the Access.bus serial bus, developed by Philips and Digital Equipment Corp. The device can collect and display information on all bus activity, including start/stop events, destination addresses, read/write requests, acknowledgments, and data. \$495.

Micro Computer Control Corp,
Box 275, Hopewell, NJ 08525.
Phone (609) 466-1751. FAX (609)
466-4116. **Circle No. 396**

PC-Based Logic Analyzer

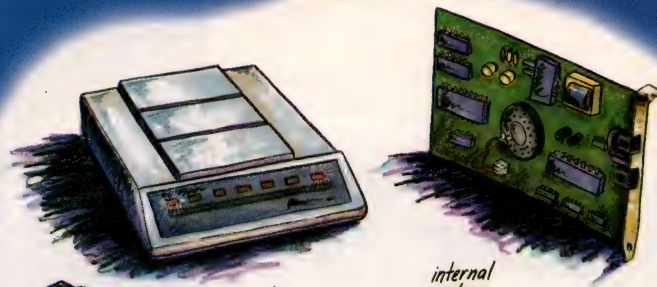
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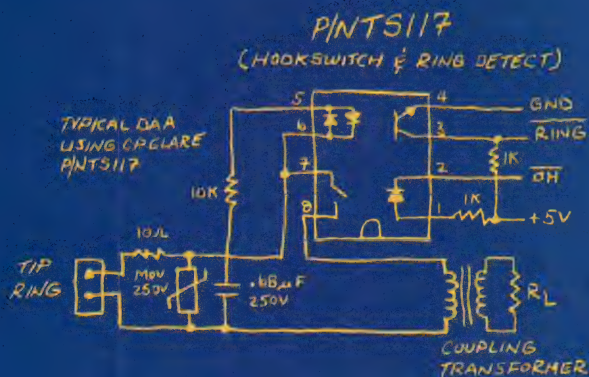


external modems

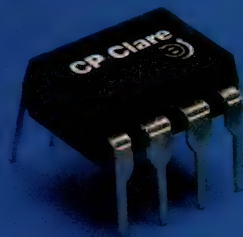
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Instruments

circuitry has 16 levels and 64 word recognizers. The boards include PC software. 100-MHz Pc/La 4810, \$2195; 200-MHz Pc/La 4820, \$2395.

Ztest Electronics Inc., 290 Larkin St., Buffalo, NY 14220. Phone (416) 238-3543. FAX (416) 238-1377. Circle No. 397



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Windows 3.X

Virtual Instrument

Hypersignal-Windows AMPS V1.1 is software that transforms a PC equipped with various A/D boards into an 8-channel, simultaneous-sampling data recorder combined with a 5-MHz spectrum analyzer/oscilloscope. The software presents simulated instrument front panels ("virtual instruments") and performs digital filtering.

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The Series 2000 offers the most solutions for your everyday test and measurement needs. The only DMMs designed by the people who use them. You.

For more information on these new DMMs call (outside CA) 1-800-854-2708 or (inside CA) 1-800-227-9781. Beckman Industrial Corporation. 3883 Ruffin Rd., San Diego, CA 92123-1898.



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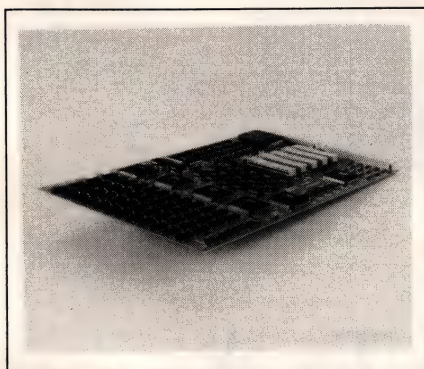
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Virtual DMM

The model 70 5.5-digit DMM has no front panel. Instead, you control the instrument over an RS-232C link from a computer or modem. You can daisy-chain as many as 32 of these software-addressable instruments from one RS-232C cable. The 4.375 x 3.25 x 0.875-in. unit draws 25 mA at 9V. The included PC software performs data-logging functions. \$239; \$199 without cables and software.

Prairie Digital Inc, 846 17th St, Prairie du Sac, WI 53578. Phone (608) 643-8599. FAX (608) 643-6754.
Circle No. 400



200-MHz Capture System

The Paladin 200-MHz synchronous data-capture system for the company's ML4400 logic analyzer also provides 1-GHz asynchronous timing analysis. The unit's trigger circuitry has 12 event recognizers. Each unit has 100 channels and comes with five 20-probe pods. \$5995 for 32-kbit/channel version; \$7995 for 128-kbit/channel version.

American Arium, 14281 Chambers Rd, Tustin, CA 92680. Phone (714) 731-2138. FAX (714) 731-6344.
Circle No. 401

50-MHz Combined Pulse And Function Generator

The 8551 is a pulse and function generator with an output frequency range of 10 mHz to 50 MHz and dc offset and amplitude range of

National consumption at all-time low.

EXTEND BATTERY LIFE WITH 5V EPROMS THAT CONSUME UNDER 10mA.



NM27LC256

Now you can get the most out of your in-line powered and battery-operated designs with our new family of high-performance 5V EPROMs. In fact, they're the only 5V solutions available today that consume under 10mA. So if you hunger for low-power EPROMs, call National for the lowdown.

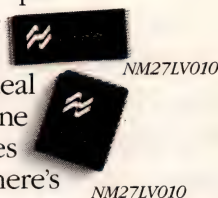
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Data shows memory excels at three.

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Our latest EPROM innovations represent a major breakthrough for the world of low-power designs: three volts. As a result, they're ideal for everything from PCs to slimline mass storage and cellular phones to consumer electronics. Now there's some data that's truly unforgettable.



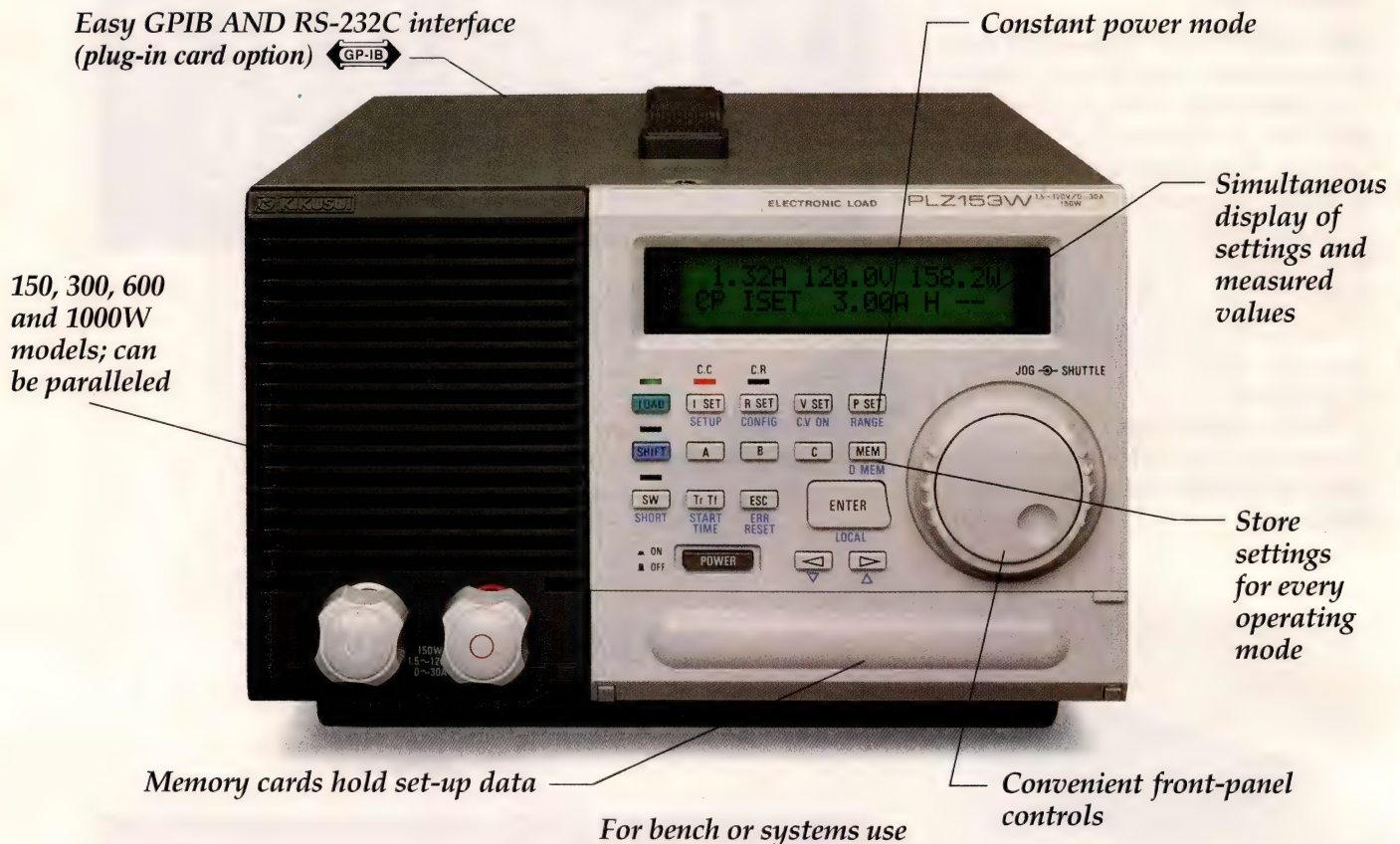
NM27LV010

NM27LV010

1-800-72-EPROM, Ext. 207



Get A Load Of This!



Closest Thing Yet To A Real-World Load

No more testing trade-offs! Kikusui's PLZ-3W series has everything you want in an electronic load. Four operating modes — constant current, voltage, resistance and power — let you simulate any real-world loading requirements.

Recreate your actual load demand on the PLZ-3W by capturing it with a DSO. Then use Kikusui's exclusive sequence mode, which acts as a 10 bit arbitrary waveform generator, to accurately replay the captured waveform on the load. For added flexibility, you can program functions and read measured values from

the front panel or the optional GPIB or RS-232C interfaces. Additional advances include programmable rise and fall times, slew rates to 4 A/ μ sec, soft start and short circuit capabilities, plus such convenience features as front panel calibration.

Find out how easily you can produce incredible load simulations for research, testing and manufacturing of all DC power devices. Contact us by calling toll free 1-800-545-8784 or

by fax at 1-310-986-1624. Kikusui International Corp., 1980 Orizaba Ave., Signal Hill, CA 90804.

KIKUSUI
KIKUSUI INTERNATIONAL CORP.

$\pm 32V$. You can set frequency to 4-digit resolution, and frequency accuracy is 0.1%. The instrument offers eight linear and logarithmic sweep modes, automatic phase lock, counted burst, and transition time control. The half-rack instrument includes 30 nonvolatile memory setups, self calibration, and an IEEE-488.2 interface as standard. \$3595.

Tabor Electronics, Box 901, Haifa, Israel. Phone 4-676868. FAX 4-673819. In US, 25 Rutgers Ave, Cedar Grove, NJ 07009. Phone (201) 239-0425. FAX (201) 857-8981. Circle No. 437



Portable Instrumentation Tape Recorders

The RD-125T and RD-135T use digital-audio-tape (DAT) technology. They offer two speeds—standard and double speed. In the double-speed mode, the frequency response is twice that of standard DAT recorders. The RD-125T records 5.0 channels of 20-kHz data; the RD-135T records 5.0 channels of 10-kHz data. You can use one channel on either unit to record 14 digital signals instead of an analog signal. \$10,500.

Teac America Inc, 7733 Telegraph Rd, Montebello, CA 90640. Phone (213) 726-0303. FAX (213) 727-7621. Circle No. 438

Test System For Mixed-Signal ICs

The Vistavision system is a high-throughput tester for mixed-signal ICs that have as many as 448 pins. Included in this class are devices

Memory you can't forget.

EPROMs from National.

Our commitment to providing a broad range of EPROMs is clearly outlined by the matrix below. We've made substantial investments in updating our fabs and processes in order to bring you innovative solutions that deliver unsurpassed performance. And that's really something worth remembering.

Standard Product

- 16kbit-4Mbit
- 100ns access times
- DIPs, PLCCs, OTPs, TSOPs
- JEDEC Std Pin Config
 - 2K-512K x 8 (byte)
 - 64K x 16 (word)

Processor-Oriented

- 25ns T_{DF} eliminates wait states
- 7ns T_{OH} eliminates glue logic
- 120ns access times
- DIPs, PLCCs, OTPs
- JEDEC Std Pin Config
 - 2K-512K x 8 (byte)
 - 64K x 16 (word)

5V Low-Current

- Active current
 - 4.5mA
- Standby current
 - 100 μ A
- 200ns access times
- JEDEC Std Pin Config

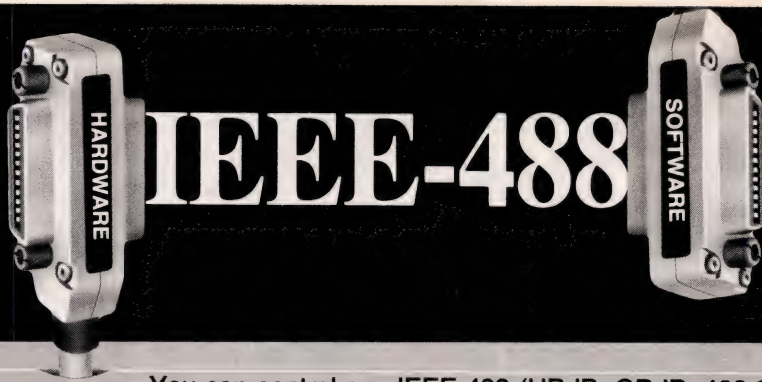
Low-Voltage

- 3.3V $\pm 0.3V$
- Low current operation (I_{CC})
 - 15mA & 20 μ A (standby)
- Low power
 - 50mW & 33 μ W (standby)
- 120ns access times
- TSOPs, PLCCs

For a free information kit and memory databook, return the reply card, give us a call, or fax us at 1-800-888-5113.

1-800-72-EPROM, Ext. 207





You can control any IEEE-488 (HP-IB, GP-IB, 488.2) device with our cards, cables and software for the PC/AT/386, EISA, Micro Channel and Macintosh II. You get fast hardware and software support for all the popular languages, plus a software library of time saving utilities. Instrument control has never been easier.

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Applications help 617-273-1818



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CIRCLE NO. 83

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No two emulators run the same. The trick is to get the best functionality you can for your investment. With the SIGNUM 8051 family in-circuit emulator you get even more... you get:

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- Bank switching

SIGNUM also has the Intel 8048, Zilog Z8 and Super-8, Texas Instruments DSP, the 8051/52 (from AMD, Siemens and Signetics), and more chips covered.

So, don't just look at in-circuit emulators. The only way to truly test an emulator is to use it. Call for your own free trial and demo disk.

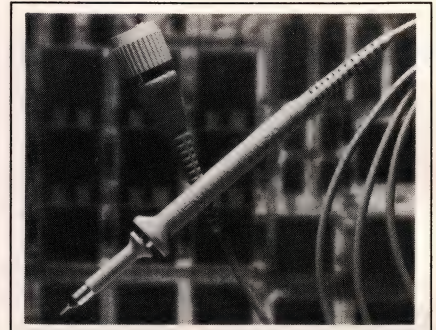
You owe it to yourself to find how much emulator you can really get for your money.

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SIGNUM SYSTEMS

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Thousand Oaks, CA 91360

Info. Tel: (415) 903-2220 FAX: (415) 903-2221



Scope Probes

B-Series molded probes offer bandwidths to 100 MHz. They are UL-certified, and their removable tips can withstand forces as high as 50 lb. The probes can compensate for scope input capacitance from 15 to 35 pF. The 10× unit, which works with scopes whose input resistance is 1 MΩ, has a series resistance of 9 MΩ ±0.25%. The probes' internal components are surface mounted on multilayer pc boards, which are encased in metal cylinders that provide electrical and mechanical shielding. From \$50.

**Tektronix Inc., Box 1520,
Pittsfield, MA 01202. Phone (800)
426-2200.**

Circle No. 440

Synthesized Signal Generator

The HP 83731A delivers precise, modulated signals for testing communications, radar, and electronic-warfare receivers in the 1- to 20-

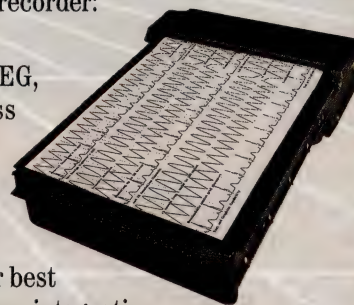
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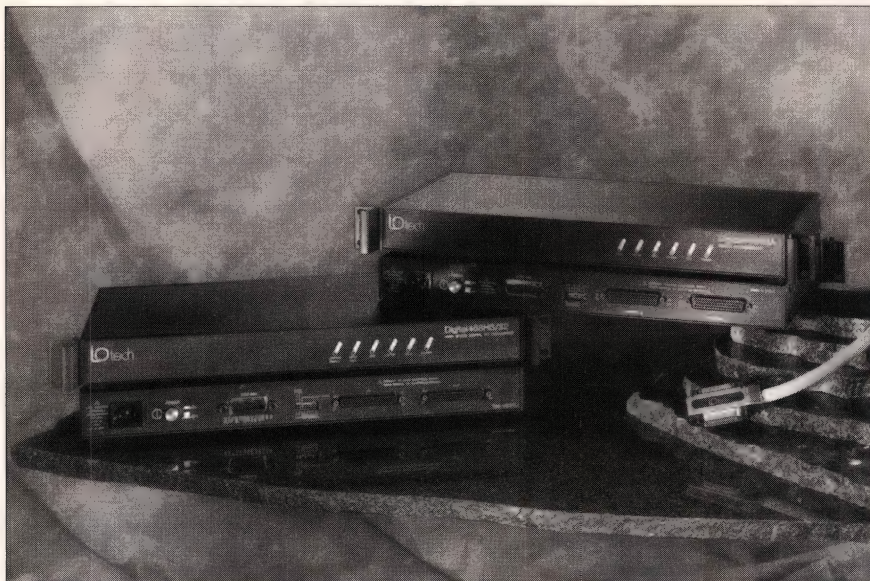
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CIRCLE NO. 85

New IEEE 488 Digital I/O Duo for High Speed or High Density I/O



Iotech's new Digital488 interfaces offer 1 Mbyte/s data transfers and up to 80 I/O lines

Iotech has introduced two new digital I/O products for the IEEE 488 bus, offering users a choice of high speed or high density digital interfacing. Both products provide a convenient and efficient means of communicating between a computer equipped with an IEEE 488 interface and non-IEEE 488 digital devices.

High Speed I/O

The **Digital488HS/32** enables high-speed data transfers between the IEEE 488 bus and components, computers, printers, plotters, BCD-compatible test equipment, and peripheral devices equipped with parallel-digital I/O interfaces. The unit can transfer 8-bit digital information at 1 Mbyte/s or 16-bit digital information at 500 Kwords/s.

The Digital488HS/32 features 16 TTL-compatible input lines and 16 TTL-compatible output lines. It also offers handshake and control lines for communication and synchronization, including two output and two input handshake lines, two status bit lines, and clear, trigger, reset, and end-of-data lines.

High Density I/O

The **Digital488/80A** enables I/O of 80 digital signals from the IEEE 488 bus via two 40-line ports, each of which can be

selected as inputs or outputs in 8-bit multiples. The unit complements each of its 40-line channels with 6 handshake/control lines, including trigger, data strobe, inhibit, and clear output lines, as well as service request and external-data-ready input lines.

High Voltage & Current Control

The Digital488/80A is available with an optional **HVCXI** high current/voltage interface that provides it with 12V, 24V, and 48V logic compatibility and allows it to sink up to 200 mA, making it ideal for switching relays and turning on LEDs.

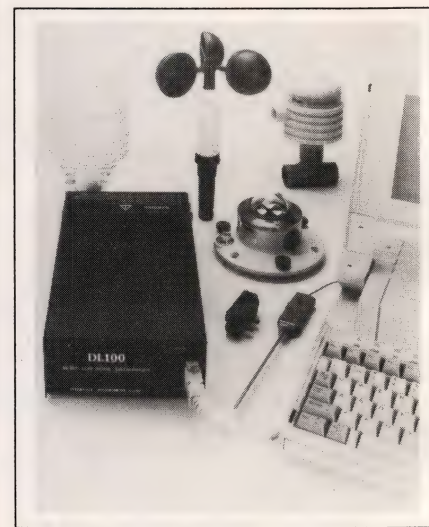
The Digital488/80A includes a non-volatile memory for default power-up determination of I/O status and logic levels across all 80 lines. The Digital488/80A also features an 8,000-byte data buffer, enabling it to capture up to 1,000 eighty-bit readings and relieving the IEEE 488 controller of the need to constantly read data from the unit.

Pricing

The Digital488HS/32 is \$795. The Digital488/80A is \$995; its HVCXI option is \$295. For more information, call **Iotech** at (216) 439-4091, or fax your request to (216) 439-4093.

GHz range. It delivers +14 dBm to -90 dBm with ± 2 -dB accuracy. Harmonics are below -55 dBc and spurious signals are below -60 dBc. The generator offers logarithmic amplitude modulation and incorporates a programmable pulse generator. \$28,500. Delivery, eight weeks ARO.

Hewlett-Packard Co, 19310 Pruneridge Ave, Cupertino, CA 95014. Phone (800) 452-0900. Circle No. 441



Portable Analog Data Logger

The DL100 battery-powered data-logging system has 24 analog inputs, each of which has a full-scale range that you can set in 10 steps from 30 mV to 30V. After you set up the logger, an operation that requires a PC-notebook PC works fine—you can remove the PC and leave the logger unattended for as long as 300 hours in a location where ac power is inaccessible. The logger, which supplies transducer excitation, uses an integrating ADC to minimize noise, and it stores as many as 100,000 readings for later uploading to a host PC. \$1500; 16-channel version, \$1200.

Interface Instrument Corp, 37845 Soap Creek Rd, Corvallis, OR 97330. Phone (503) 745-5620. FAX (503) 745-7470. Circle No. 442

The DMMs our customers designed.

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The Series 2000

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Capacitance Meter to 2000μF

Auto Min Max Avg

Probe Hold™

0.01 Resolution

Fault Finder™ Intermittent Detector

4 Digit, 10,000 Count Display

True RMS (AC or AC+DC) (2020, 2030)

Peak Hold (2020, 2030)

Fiberoptic Backlight (2020, 2030)

Protective Holster with Flex-Strap™

50ns Pulse Detector

True RMS (AC or AC+DC) Reading. The 2020 and 2030 allow the True RMS value of an input to be displayed. This feature is necessary when working with nonsinusoidal waveforms or signals that contain harmonics from switching power supplies. Either the AC component or both the AC+DC components can be easily selected.

Analog/Digital Display. The large digits are easily seen from a distance. The 41 segment bar graph updates 20 times a second and is excellent for peaking and nulling as well as indicating the presence of noise or intermittents.

Probe Hold. Probe Hold automatically records a stable input signal and displays it from memory after the probes have been removed. A stable reading is acknowledged with a tone.

Auto Min Max Avg. Used as a simple datalogging device, this feature records the maximum and minimum input levels. Then, through the MENU system will display the minimum, maximum, maximum minus the minimum, and the running average. Auto Min Max Avg remains in the autoranging mode for the highest possible resolution.

Fault Finder™ Intermittent Detector. Emits a variable tone that responds very fast to changing inputs. Intermittents are quickly identified by a crackling sound. Tone allows for very easy peaking and nulling of circuits.

Peak Hold (2020/2030). Capture input levels as short as 1ms with Peak Hold. Ideal for measuring very fast events such as current surges and voltage spikes. Monitor a power line and reveal problem occurrences.



Safety Alerts.

- Incorrect Input Warning alerts visually and audibly, when a lead is in the current jack and a non-current function is selected.
- Dangerous Voltage Alert indicates inputs over 25V with two tones and a special LCD annunciator.
- Low Battery Cutoff blanks the LCD to ensure that the meter never displays an incorrect reading due to low battery voltage.

Specifications (at 23°C ±5°C; <70% R.H.)

AC & DC Voltage	
Ranges	100mV, 1V, 10V, 100V, 1000V
AC Accuracy (crest factor<1.5) (45Hz-2kHz, 3dB, >10kHz)	2.0%rdg ±3dgt
DC Accuracy	
2010, 2020	0.25%rdg ±2dgt
2030	0.10%rdg ±2dgt
Maximum Resolution	0.01mV in 100mV range
Input Impedance	10M
Conversion Type	
2010	Average Sensing RMS Indicating
2020, 2030	AC, AC+DC True RMS
Crest Factor for True RMS	1:1 through 5:1
Normal Mode Rejection Ratio	>60dB at 50/60Hz
Common Mode Rejection Ratio	>120dB up to 1000VDC
Transient Protection	6kV
Overload Protection	1000VRMS
AC & DC Current	
AC & DC Ranges	1000μA, 10mA, 100mA, 1000mA, 10A, 20A
Basic AC Accuracy (45Hz-1kHz, 3dB >10kHz) (619) 495-3200 • FAX: (619) 268-0172 • TLX: 249031	1.7%rdg ±3dgt
Basic DC Accuracy	
2010, 2020	0.5%rdg ±1dgt
2030	0.35%rdg ±1dgt
Maximum Resolution	0.1μA in the 1mA range

Resistance	
Ranges	100, 1000, 10k, 100k, 1M, 10M, 20M
Accuracy	
2010, 2020	0.5%rdg ±4dgt
2030	0.3%rdg ±4dgt
Maximum Resolution	0.01 in 100 range
Overload Protection	500VRMS
Diode/Continuity Test	
Range	2V
Accuracy	1.0%rdg ±5dgt
Continuity Indication	Continuous tone 75 ±25
Overload Protection	500VRMS
Pulse Detector Type: TTL, CMOS; Threshold: 2.6V; Pulse Indication: To 20Hz-single tone, continuous; Pulse Width: (min) 50ns; Pulse Rise Time (max): 10ns	
Capacitance	
Ranges	20nF, 200nF, 2μF, 20μF, 200μF, 2mF
Accuracy	2.0%rdg ±2dgt
Maximum Resolution	100pF in the 20nF Range
Overload Protection	500VRMS
Frequency	
Ranges	19.999kHz, 199.99kHz, 1.999MHz
Accuracy	0.2% rdg ±1dgt
Maximum Resolution	1Hz in the 19.999 range
Overload Protection	300VRMS

Accessories

Test Lead Sets

DL243B	Basic test lead kit.
TL246B	Large, heavy duty alligator clips.
TL247	Tweezer probe.
DL248B	Deluxe test lead kit.
DL249	SMD test lead kit.

Carrying Cases/Holsters

VC221	Reinforced vinyl case. (Fits meter with holster)
VC201	Reinforced, fabric lined vinyl case. (Fits meter without holster)
H221/H221Y	Gray holster/Yellow holster.

Probes/Current Clamps/Converter

HV231-10	40kVDC high voltage probe.
RF241	650MHz RF probe.
CT231	2-150A AC current clamp.
CT232	1-1000A AC current clamp.
CT233	0-600A AC/DC current clamp.
CT234A	4-400A AC current clamp.
CT236	10-500A AC current clamp.
TC253	Temperature converter. Probe required.
TP254	General purpose Type K thermocouple probe. TC253 is also required.
TP255	Type K thermocouple probe with beaded end. TC253 is also required.

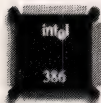
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New Products

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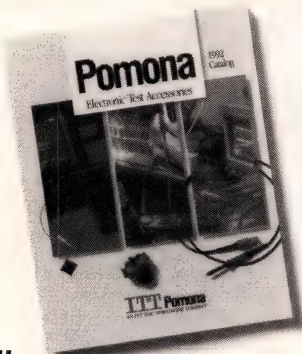


Pomona test accessories make sure your systems and circuits are working the way they should.

Professionals rely on the quality and accuracy of Pomona probes, test leads, or the newest IC test clips, to make their design, test, or repair faster, easier, and more reliable.

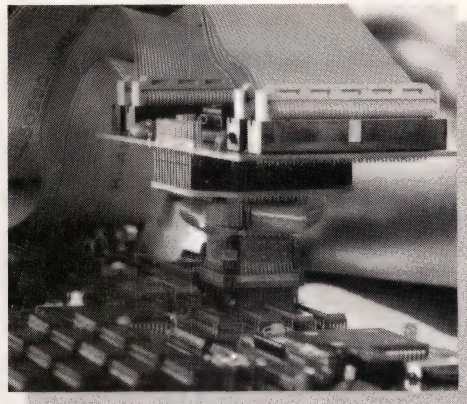
Broadest Selection
Selection and availability are two primary reasons Pomona is the world's leading supplier of quality test accessories for electronics.

More than likely, an authorized Pomona test accessories stocking distributor carries exactly what you need.



Call. FAX or write for your free copy of Pomona's 140-page 1992 Electronic Test Accessories Catalog.

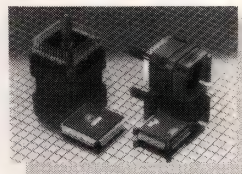
SMT & IC Clips



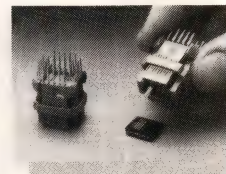
Standard density FIN Clip provides easier access from high-density QFP product leads (100, 132, 196 pin) to standard .100 center headers.

Flexible interface ribbon (4) hooks to socketed headers on custom PCB (100, 132, 196 pin).

High-density I Clip provides access from C test clip (100, 196 pin) to high density .050 center headers.



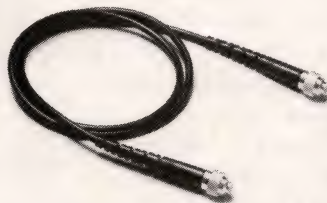
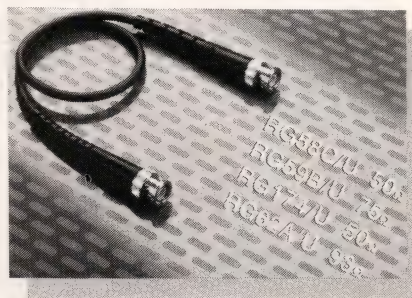
32-pin (7x9) PLCC EEPROMs are easily tested with Pomona's 5733 QUAD CLIP®.



Access high-pin count microprocessors such as Motorola's 68020 or 68030 (132-pin), or Intel 80386S (100-pin) devices with QFP test clips.

COAX /BNC Cables & Kits

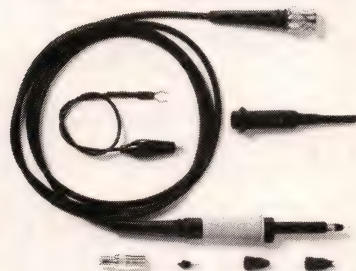
Select from industry's largest selection of quality coax and cable assemblies. Right photo shows 2249 BNC Cable featuring molded stress protection. Available in RG58C/U, RG59B/U, RG174/U, and RG62A/U styles.



Maxi Universal Adapter Kit (right) contains large variety of coax connectors, intermediate couplers. Male and female. Plus double banana post, attenuator "T" and plug adapters. BNC, SMA, RCA, UHF, TNC, "F" or "N". Universal Adapter Cable Assembly (left) works ideally with kit.



100-300 MHz Oscilloscope Probe Kits



Ten quality oscilloscope probe kits provide a complete selection of 100, 200, and 300MHz applications. Modular in design means flexibility and repairability for lab or field uses. Kits feature compatibility to all oscilloscopes, complete set of accessories, and excellent performance up to 300MHz.

Specialized Test Probes/ Alligator Clips

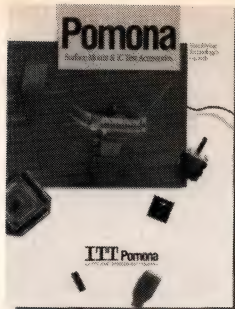
Miniature and heavy-duty test applications are answered with a selection of mini, medium, and disposable plastic insulated alligator clips; spring-loaded test probe for SMD and lead trace testing; large plastic insulated alligator clips; and, heavy-duty insulation-piercing test probe for automotive and heavy wire gauge tests.



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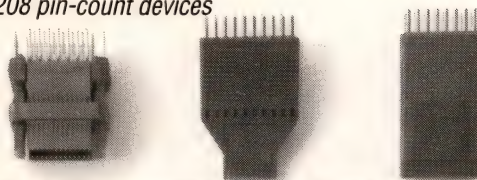
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ACCESSORIES BROCHURE!**
Includes newest Microprocessor Test
Clips for up to 208 pin-count devices

Product Guide



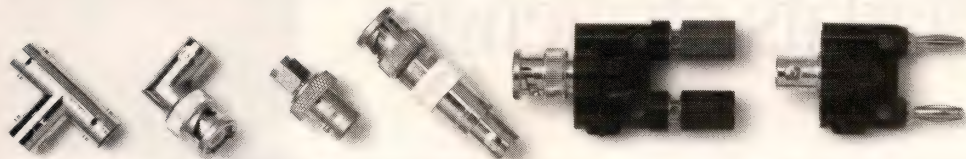
DIP, SOIC, PLCC, PGA,
LCC, PQFP,
Clips & Adapters

**IC Test Clips
& Adapters**



Standard Miniature
Banana, Pin Tip, Plugs,
Jacks & Binding Posts

Plugs & Jacks



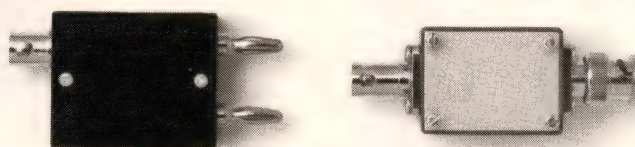
Banana, BNC, TNC,
UHF, Type N, SMA,
Phone, Phono, Alligator
Adapters, Terminators,
Panel/Bulkhead
Receptacles
Tube Test Sockets

Adapters



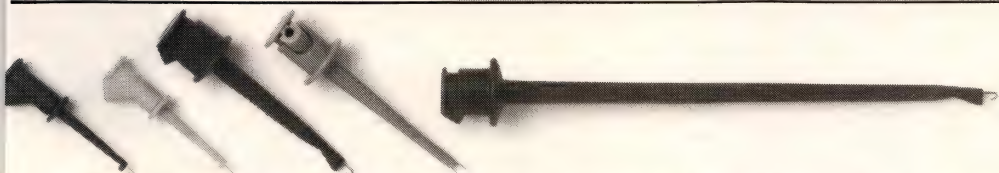
BNC, TNC, F, N, SMA,
SMB, SMC, Triaxial,
Twinaxial Audio
(EP, XLR) Cabling
Instructions

Connectors



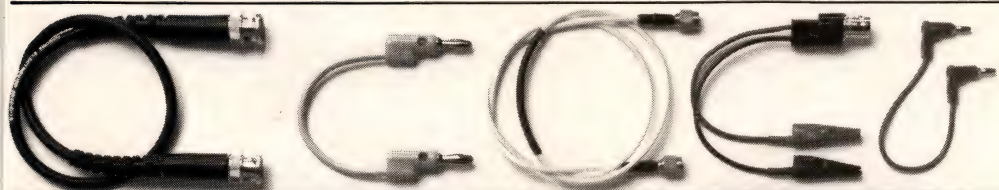
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Test Clips**



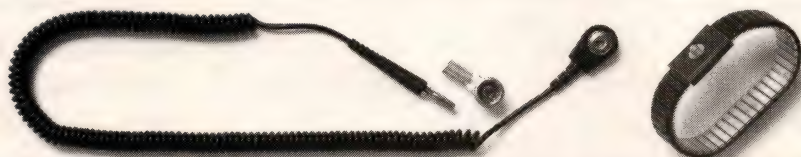
Miniature & Standard
Banana, Spade Lug,
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Alligator, UHF, N, Triax,
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**Jumpers
& Cables**



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Repairable, Tweezer,
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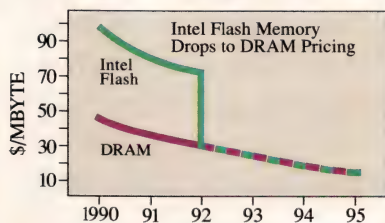
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FLOORPLANNING: LAYOUT COMES TO THE LOGIC DESIGNER

JOHN C NAPIER, Technical Editor

Using floorplanning tools to do a preliminary physical layout and predict interconnect delays lets you short-circuit the layout-and-resimulate loop.

SOME IC-INDUSTRY EXPERTS SAY THE CAE market offers no good floorplanning tools. Yet Compass Design Automation has had a product on the market since May 1989, and silicon vendors such as LSI Logic and Vertex Semiconductor offer floorplanners for their customers' use. Given starting prices of \$25,000 to \$50,000, the people who buy these floorplanners must need them and expect to use them.

Floorplanning tools let IC logic designers do preliminary layout and estimate interconnect delays in minutes to hours on a workstation using software priced from \$30,000 (Fig 1). Without these tools, designers must wait days to weeks for a layout house to create a physical layout using software priced on the order of \$300,000. Floorplanner vendors and users of in-house tools claim accuracy better than 90%

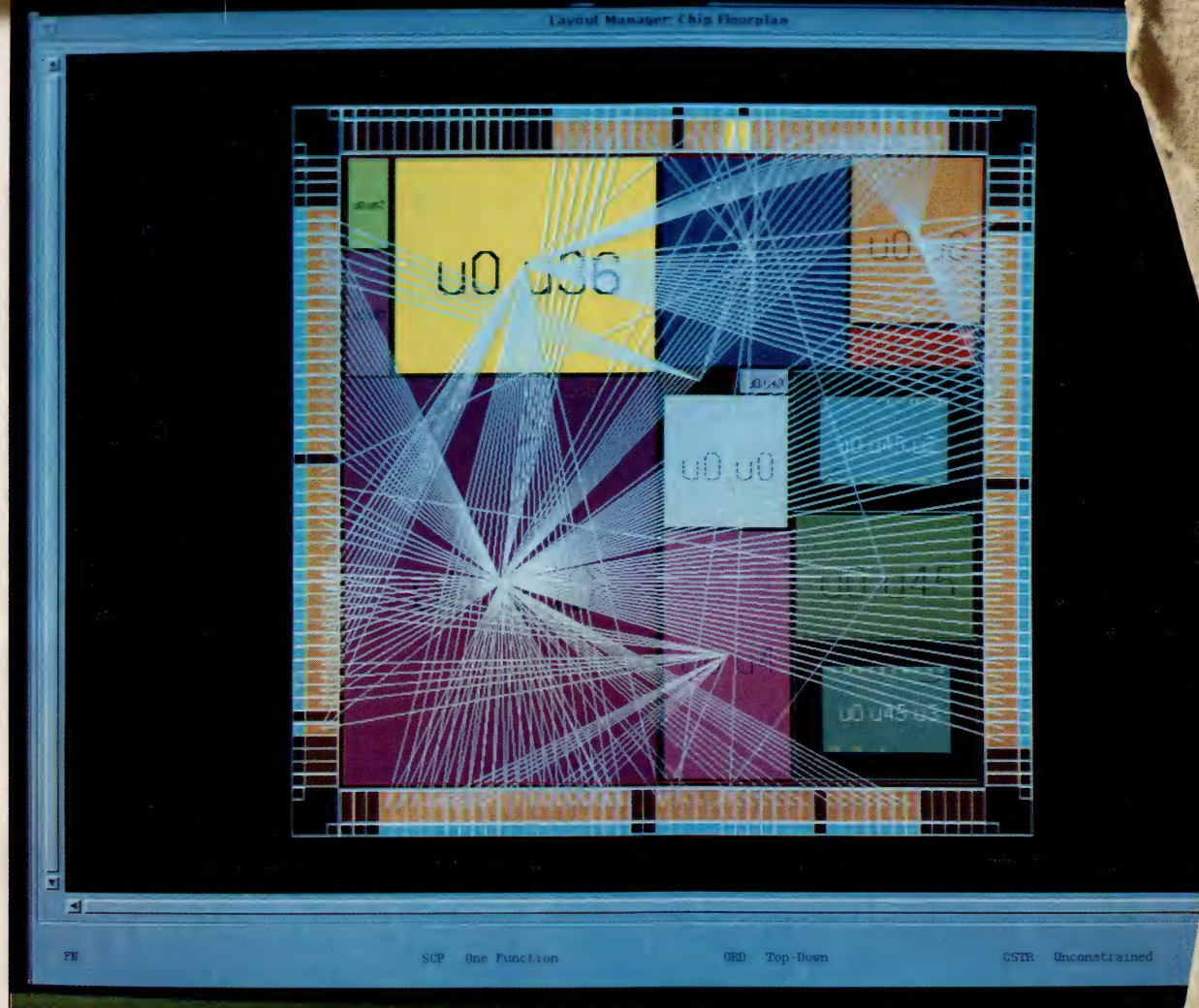


Fig 1—The LSPACE floorplanning tool from LSI Logic displays interconnect conceptually by mapping it to the center of each logic block.

for their tools' estimates of interconnect delay.

One reason floorplanners—including good ones—have begun emerging is that feature sizes have dropped steadily. Feature sizes impact the timing budget through both geometric and physical principles. By simple geometry, smaller-size gates leave more room on the die for more gates to talk to each other across longer interconnect. Physically, smaller gates switch faster. Many of today's tiny gates switch at subnanosecond speeds.

A state-of-the-art design in 1987 may have had a gate delay of 1.4 nsec and a wire delay of 0.3 nsec from one gate to the next. One of this year's designs may have a gate delay of 0.5 nsec

and a wire delay of 0.7 nsec (Fig 2). Such numbers shift the focus of the timing budget from gates to interconnect. In fact, interconnect delay often determines whether a logic design still works after physical layout. Thus, layout considerations are inching steadily closer to the front end of a logic designer's work. As submicron feature sizes, subnanosecond gates, and 100,000-gate designs become standard, look for floorplanning to become a routine part of ASIC design.

The term "floorplanner" originated with IC designers who create physical-level layouts. The name can be misleading: Logic-partitioning tools, die planners, and preliminary-layout tools all lay claim to the name "floorplanners." Also, the name fails to reveal which of several approaches—if any—a floorplanner uses to predict postlayout timing (see box, "How floorplanning tools estimate timing"). You have to read the fine print to know what you're buying.

Logic-partitioning tools let you allocate functions from a logic hierarchy to silicon real estate. Such software packages would more accurately be called partitioning tools. Die planning is estimating the die

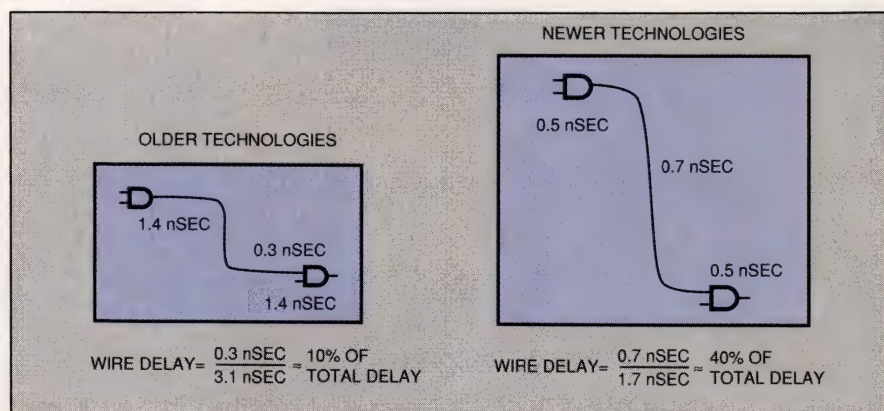


Fig 2—Interconnect delay dominates the total delay for newer technologies.

area required to implement a logic design and making sure that blocks that talk to each other often or at high speeds are spatially close. The logic designer's goals are twofold: utilizing the entire die area and minimizing the length and count of wire between blocks. This type of tool is a die planner. Some of these tools can also calculate a rough estimate of interconnect delay.

Preliminary-layout tools—called floorplanners in this article—let you allocate on-chip physical area and get quantitative feedback on the resulting interconnect delays and routing congestion. Floorplanners are desktop tools for interactive use; the tools are not batch

oriented. Within minutes after inputting data, the floorplanner exports timing data to your simulator for another design-verification run.

Using floorplanners

Floorplanning serves as an interactive link between logical design and physical layout. As a logic designer, you floorplan a design after a trial logical design and schematic capture. At that time you should have the following in hand:

- A logic hierarchy, or list of functional blocks
- In cell-based designs, a list of compiled blocks
- A netlist

How floorplanning tools estimate timing

Floorplanning tools usually use one of two approaches to produce timing estimates. The statistical approach is associated with die planners; the routing-based approach is typical of floorplanners.

When using a tool without trial-layout capabilities, you can make preliminary estimates of layout timing effects based on the total gate count and number of loads. Using this approach, which is sometimes called the global-incremental-capacitance method, you assign the same capacitance to any wire with a given number of loads. To refine this crude approach, you may adjust estimates to reflect block size and location within the logical hierarchy. This method is a rule-of-thumb, or statistical, approach: You extrapolate from average

prelayout delays for a broad class of interconnect based on information from previously routed designs.

A floorplanner, on the other hand, does a simplified, preliminary layout. The tool models interconnect, with the exception of clock nets, as lumped capacitance. It determines wire length by performing iterative routings through a grid of user-defined size. You may be able to designate a finer grid or more iterations to improve accuracy. After modeling other nets as lumped capacitances, the floorplanner may perform RC-tree, or distributed-parameter, routing for clock nets. The RC-tree technique models trace resistance and capacitance as well as gate capacitance and the distribution of gates along traces.

- A library that characterizes the silicon technology you'll be using.

By this point, you have also identified cells as "hard," "firm," or "soft." The function of soft macros is fixed—for example, implementing an 8051 microcontroller—but the cell's placement and routing are adjustable. For firm macros, function and placement are fixed, but routing depends on how you use the cell in the design; for example, varied fan-outs. All three aspects of hard macros are fixed.

Floorplanners perform most tasks automatically on a first pass and let you manually adjust the resulting design. The tasks fall into four categories: specifying pinout, placing logic blocks, routing the wire, and satisfying design constraints for special signals.

To specify pinout, you designate the number and size of I/O pads around the perimeter of the die. The pad count follows from logic-partitioning decisions. Pad sizes correspond to the power through the pad and the bondout method you employ. The NCR Chip Planner, an in-house, silicon-specific die planner, attempts to spread pads so that the die is as square as possible. If the core geometry limits the pad layout, the tool spreads the pads as evenly as possible around the edges. The tool also recommends the number of power and ground pads based on total gate count and the number of simultaneously switching chip outputs.

During block placement, a floorplanner translates the logic hierarchy to a physical area allocation, as Figs 3 and 4 show. Floorplanners perform this function automatically; die planners may not perform it at all. As in pc-board layout, blocks that accept chip input or output should be near their respective I/O pins. Large, hard-coded blocks tend to draw substantial power and therefore should also be near the

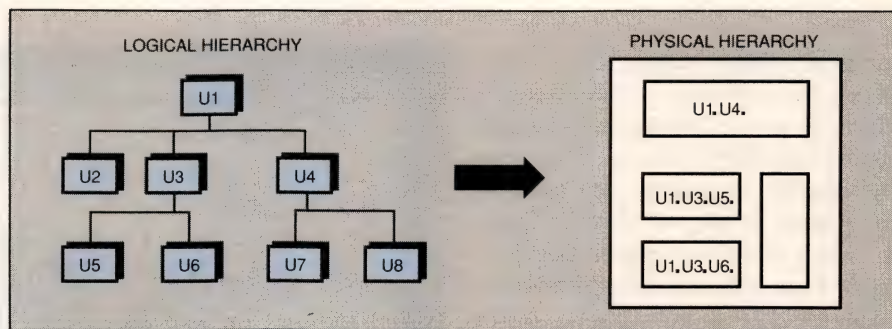


Fig 3—The U numbers connect the logical and physical hierarchies. The top node of the logical hierarchy identifies the overall circuit name. Intermediate nodes identify subfunctions. The "leaf nodes" at the bottom of the logical hierarchy correspond to the smallest blocks shown on the floorplan of the ASIC's physical area.

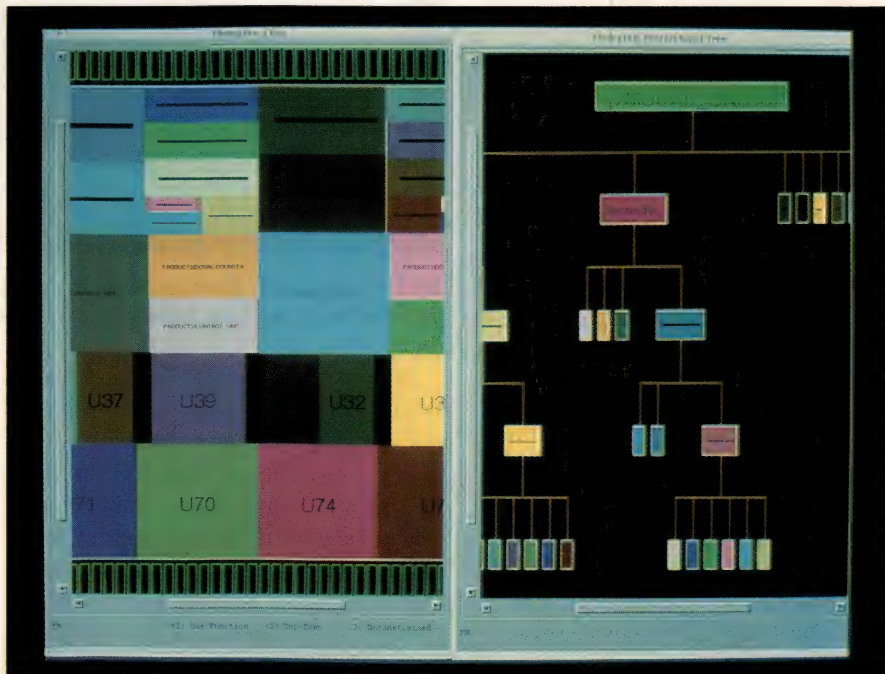


Fig 4—LSI Logic's LSPACE floorplanner shows logical and physical hierarchies in side-by-side windows.

outer edges of the chip to share power and ground with I/O.

Floorplanners do wire routing automatically after block placement. Clock nets and critical nets require special treatment. With picosecond clock-skew budgets, the task of routing clock trunks at Vertex Semiconductor is done independently of floorplanning, according to Bob Feretich, vice president of engineering. Because leaf nodes, which are at the bottom of a logic hierarchy, receive priority in automatic placement, you should define critical nets

at that level. If you do, floorplanning tools are more likely to meet that constraint on the first pass.

After routing, a floorplanner displays a congestion map that illustrates wire density. Simple display schemes are line based. They show all the nets connected to a logic block as lines radiating from the center of that block (Fig 1). An alternate line-based display mode illustrates the gross density of inter-block nets by using variations in a single line's thickness or color.

The more detailed congestion

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maps are area based. They illustrate wire density through each block of a grid by means of color coding, as Fig 5 shows. Whatever the display technique, you use the congestion display to identify areas in which the floorplanner failed to meet your logic-design constraints, such as critical net timing, or in which physical-design rules may not be met during the final place and route. Such areas are candidates for reworking by hand.

After you've completed your floorplan, in most cases you resimulate; that is, you output your timing data to your simulator and rerun your design-verification sequence. On your last iteration, you send your floorplanner output to a place and route tool. This output takes the form of a gate-level description such as an NDL file or an EDIF file. Such a file contains descriptions of raw coordinates, busing, and the regrouping of block information.

Vertex Semiconductor's Bob Feretich says, "It's a common misperception that there is no penalty for floorplanning." In fact, using floorplanning incurs an area penalty that buys more predictable timing by placing blocks at hard-boundary locations before the final place and route. Barbara Kalkis, director of marketing communications at Compass Design Automation, says that the maximum area penalty is about 25% in users' experience with the company's tools. On the other hand, using a floorplanner may increase area utilization by as much as 25% because of streamlined routing, says Daniel Skilken, director of worldwide product marketing for Compass. The characteristics of a particular design determine net area loss or gain. Even if floorplanning increases the area of your design, you'll still benefit from the reduced number of layout cycles and the attendant costs.

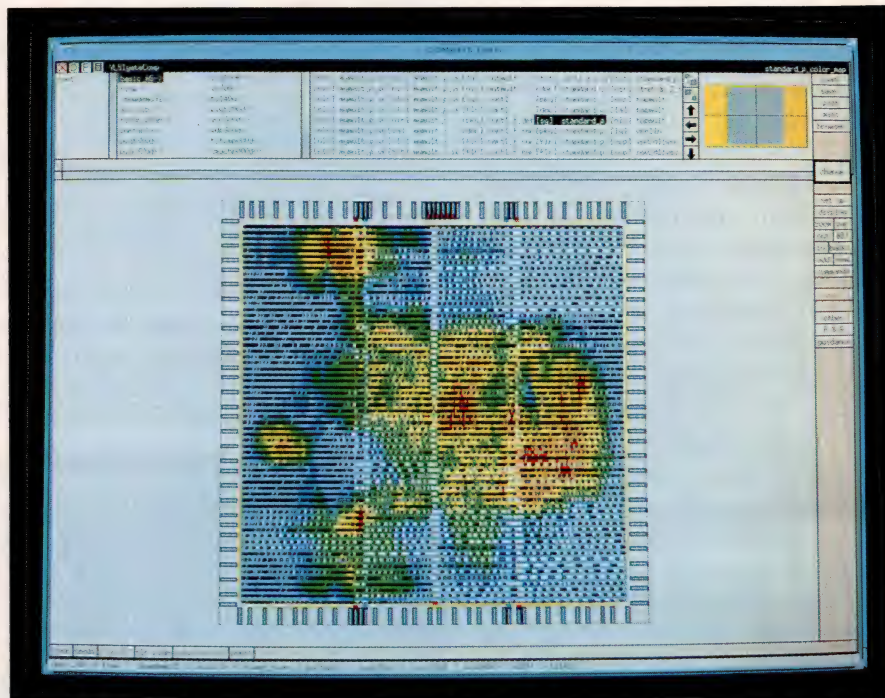


Fig 5—Color coding shows variation in routing congestion in Compass Design Automation's Gate Assistant and Chip Assistant floorplanning tools.

Because a floorplanner acts as a bridge tool between logic design and physical design it requires library files that characterize the target silicon. To protect competitive advantage and market position, semiconductor manufacturers keep many physical technology specifications confidential. Floorplanner vendors have to encrypt such data to include it in their tools.

Third-party tools

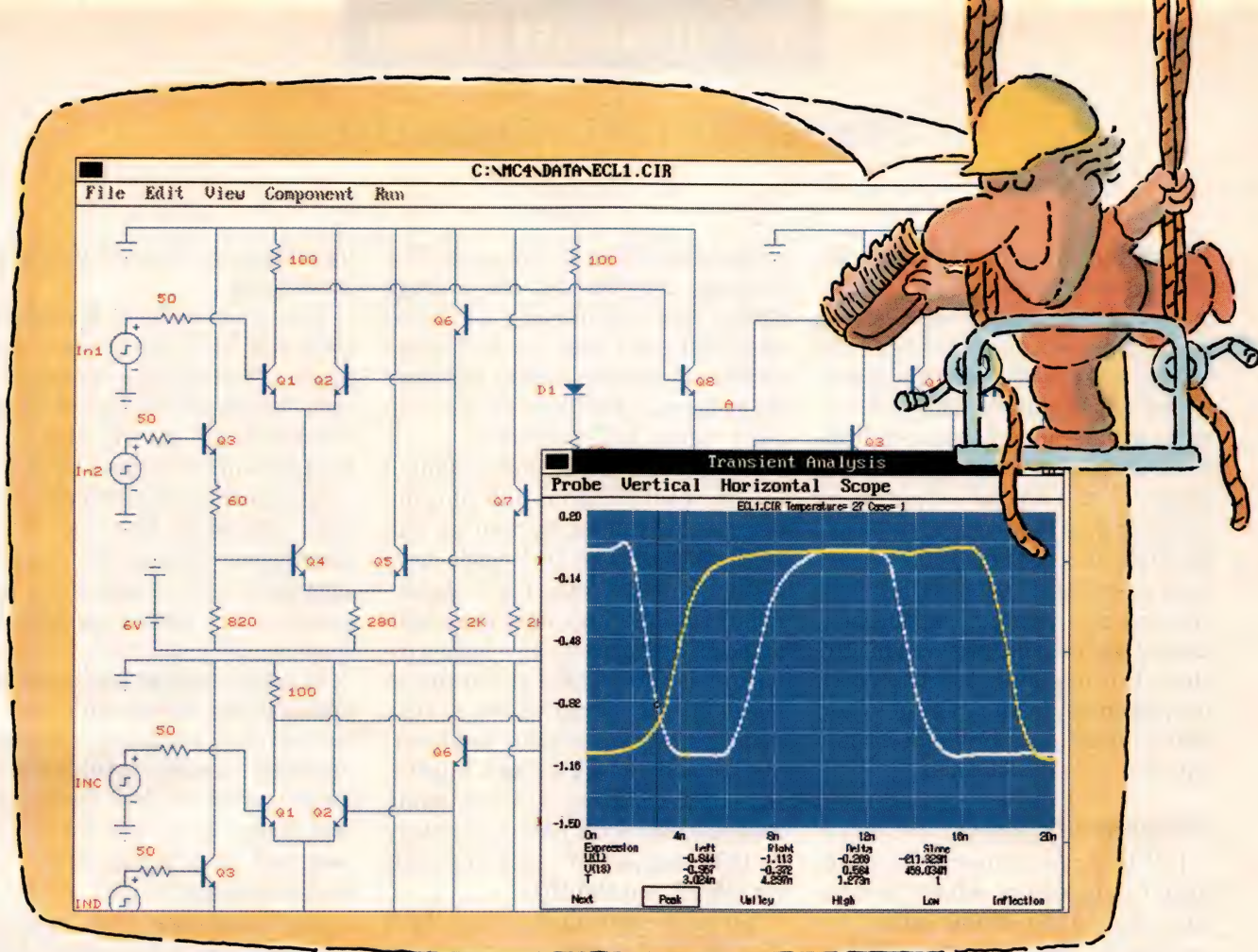
Third-party floorplanners can be useful for semiconductor companies who want tools without developing them in house and for systems houses. Two examples of third-party floorplanners are a 3-year-old tool from Compass Design Automation and Cadence Design Systems's newly announced Preview tool.

Compass offers two floorplanning tools: Chip Assistant for cell-based design and Gate Assistant for gate arrays. The tools can create floor-plans automatically, or you can control placement man-

ually for important blocks. A color-coded display shows net density and the routability of the floor-planned design.

Compass' floorplanning tools accept input from 10 major vendors' schematic-capture packages. The floorplanners automatically calculate interconnect delay estimates. This information is suitable for back annotation into any of 13 CAE tools from the 10 vendors for timing verification and place and route. Among those tools are simulators from Mentor Graphics (Wilsonville, OR), Cadence, Dazix (Huntsville, AL), and Viewlogic (Marlboro, MA). The floorplanners can be used for silicon from seven vendors, including National Semiconductor (Santa Clara, CA), Hitachi (Brisbane, CA), and Sierra Semiconductor (San Jose, CA). The tools each sell for \$50,000. Fig 5 shows a screen shot of a Compass congestion display.

Cadence Design Systems announced Preview, a new floorplanner, at this year's CICC (Custom

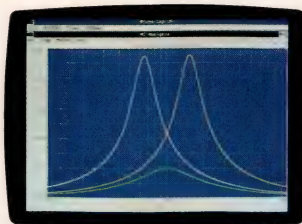


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Integrated Circuits Conference). The tool is slated for shipping during the third quarter of 1992 for Sun-4 workstations; versions for several other workstations will ship in the fourth quarter. Preview accepts input from schematic-capture tools or hardware-description languages or as a mixture of gates and behavioral-level blocks. The tool's hierarchy manager maps the behavioral description to physical blocks and provides a link between partitioning logical and physical hierarchies. Preview does automatic block floorplanning, estimates area and timing based on a preliminary layout, and sells for \$25,000.

Silicon-specific tools

LSI Logic recommends floorplanning to customers whose designs have more than 10,000 gates, according to the company's Design Tools Marketing Manager Arun Kelapure. He says that most of the company's ASIC-designer customers have bought the company's LPACE and LBOND floorplanning tools. These tools ship bundled with Silicon Integrator, LSI's \$80,000 design tool set. The average customer makes designs in the size

range of 30,000 to 40,000 gates. The company projects that the average design size will increase to 70,000 to 80,000 gates over the next three quarters. As gate counts increase, floorplanners are likely to see even more use by LSI customers.

Fujitsu's internal floorplanning tool is called Macaroni and runs under the X-Window System on Sun workstations. The tool reads from Fujitsu's netlist format and supplements it with a file containing placement information. It also makes capacitance-based timing estimates for simulation purposes. Nitin Deo, manager of applications engineering for ASIC marketing at Fujitsu, says the company started using floorplanners with ECL technology in 1987 and is now using the tools for CMOS and BiCMOS.

Vertex Semiconductor uses three classes of floorplanning tools in house, according to Bob Feretich. The first, called a master-slice compiler, designates area for I/O, standard cells, and routing ("master" here means without metallization). The second class of tool acts as a front-end to place and route tools. The third lets the company's ASIC-design customers cluster groups of

logic functions to make timing more predictable.

The future of ASIC floorplanning tools may be in the hands of silicon houses. According to Compass Design Automation's Daniel Skilken, one key to the growth of floorplanners is foundry support. Floorplanning burdens the silicon vendor with supporting files that describe such layout data as cell size, legal placement sites, base array architectures, and calculating wire delay from layout geometries.

In return for that additional work, however, the vendor can expect better customer satisfaction because of reduced timing problems and smoother work flow during place and route. In return for their investment in a floorplanner, ASIC designers stand to gain control over timing and reduce their dependency on layout turnaround cycles. And, of course the third party to the transaction, the EDA vendor, gets to sell more of a new category of tool. **EDN**

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For more information . . .

For more information on the floorplanning tools discussed in this article, circle the appropriate numbers on the Information Retrieval Service card or use EDN's Express Request service. When you contact any of the following manufacturers directly, please let them know you read about their products in EDN.

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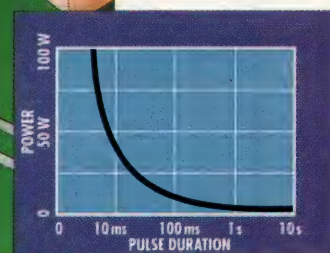
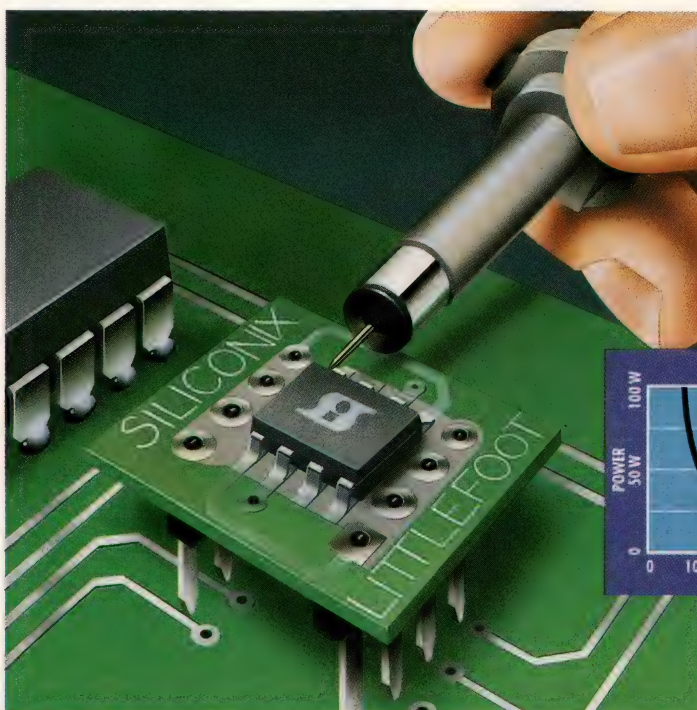
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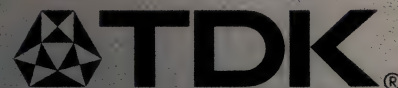
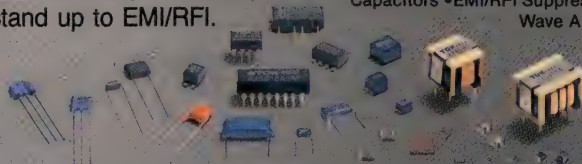
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CIRCLE NO. 89

Software package lets you postpone selecting field-programmable parts

The place-and-route modules of the FPGA Foundry software package accept timing constraints that let you define clock restrictions or path delays. The constraints alleviate the necessity of running several place-and-route iterations; the deterministic result will either meet your constraints or fail to complete. On failures, you can relax your constraints and try again.

The software provides device independence by converting your design into low-level-logic intermediate data structures. However, the software still maintains whatever

device-specific information you provide as part of the structure. As a result, you can design to a particular FPGA using macrocells and logic geared toward that architecture, yet still experiment with alternatives. Similarly, you can use the software to prototype or convert designs between masked semicustom implementations and FPGAs.

Outputs from the software include a cross-reference file, a utilization report, a file containing timing delays for back annotation into your simulator, and an output file to program the FPGA. The cross-

reference file lets you find buried, replaced, or deleted nodes between the schematic and the layout. The report generator provides feedback on path and net delays, logic-block and I/O utilization, and remaining FPGA resources.

The software runs under MS Windows on DOS workstations and on Unix-based workstations running the X-Window system and Motif. Prices start at \$18,000.

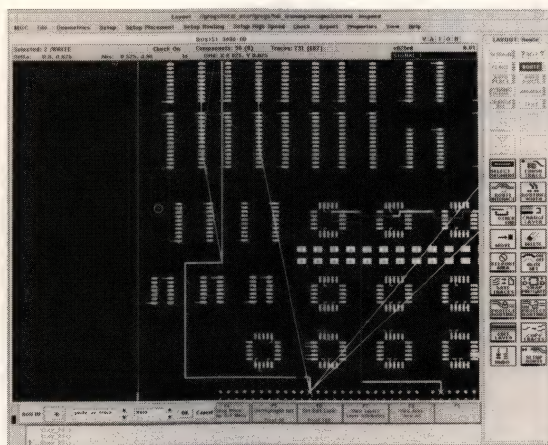
Neocad Inc, 2585 Central Ave, Boulder, CO 80301. Phone (303) 442-9121. FAX (303) 442-9124.

Circle No. 734

Design system for pc boards and MCMs addresses electrical and physical rules

Board Station 500, a system for designing pc boards and multichip modules (MCMs), combines high-speed analysis with place-and-route algorithms that use timing constraints. As a result, the system can help you control and analyze physical effects and maintain signal integrity. It identifies electrical-rule violations in real time and guides you in meeting design requirements.

To use the system, you specify a set of electrical rules: method of interconnect, topology constraints, allowable interconnect delays, and impedance characteristics. The system then maps those rules into a set of physical rules. The high-speed, interactive place-and-route algorithms use these physical rules, thus enabling the physical representation to meet the electrical requirements you have specified. The



principle physical rules are net topology, minimum- and maximum-length control, stub-length control, matched-length control for elimination of clock skew, via limits, automatic termination assignment, layer restrictions, balanced-pair routing, parallelism control, and shielding generation.

The system runs on HP Apollo, HP Series 700, and Sun SPARC workstations. \$125,000.

Mentor Graphics Corp, 8005 SW Boeckman Rd, Wilsonville, OR 97070. Phone (800) 547-3000, Dept 109, or (503) 685-8000. FAX (503) 685-8001.

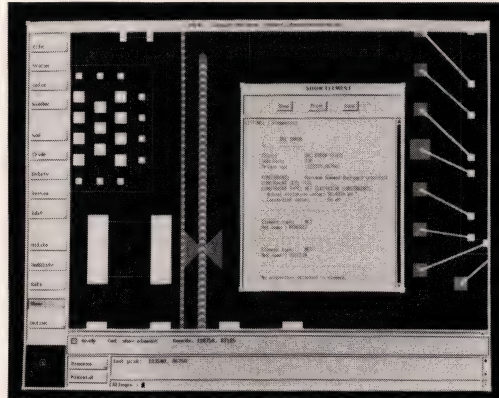
Circle No. 735

Group of software tools checks board layout and design

The Allegro CBD (correct-by-design) suite of tools facilitates board design by interactively checking design, electrical, and physical rules. The tools have the potential to eliminate iterative post-design verification and validation.

The CBD system allows electrical, physical, and thermal constraints of three types: always enforced, deferred until the design is batch-mode checked, or not enforced. In addition, you can lock constraints to prevent users from overriding them. If you define constraints properly, you can avoid difficulties such as settling delays, timing skew, signal reflections, and crosstalk.

To ease constraint development, you can group signals, components, or other features. Further, you can define technology-dependent or



technology-independent constraints for particular conductor, dielectric, and positive- and negative-plane layers. Technology independence lets the software impose the constraints on boards fabricated using printed-circuit, hybrid, multiwire, or any of the multichip-module technologies.

The software is a free upgrade

to Allegro customers who have a maintenance contract. Depending on software configuration, new users can buy the software for \$12,500 to \$60,000 to run on Sun, DEC, IBM, and HP-RISC workstations.

Cadence Design Systems, 2 Omni Way, Chelmsford, MA 01824. Phone (508) 256-2300, ext 247. FAX (508) 250-0087. Circle No. 736

Workstation brood adds low-end machine and servers

An entry-level workstation and four servers expand the HP 9000 Series 700 family of PA-RISC-based workstations. The Model 710 has an entry-level price of \$7490 and delivers 49.7 SPECmarks, 57.9 MIPS, and 12.2 Mflops using a 50-MHz CPU.

The base machine is diskless, has 16 Mbytes of memory, handles graphics having as many as eight image planes, and includes a 19-in., 1280 × 1024-pixel-resolution grayscale monitor. Color options include a 16-in. 1024 × 768-pixel monitor (\$4000) or a 19-in. 1280 × 1024-pixel monitor (\$6500).

You can add as much as 840 Mbytes of internal disk storage in four half-height slots or 9.4 Gbytes



using external disk arrays. The low-end workstation also accepts 1.44-Mbyte, 3½-in. floppy-disk drives, CD-ROM storage, or 2 Gbytes of 3.5-in. DDS (direct-digital-synthe-

sizer) tape. You can increase the computer's main memory to as much as 64 Mbytes using error-correction-code single inline memory modules (SIMMs).

The four servers come in four configurations ranging in price from \$23,440 to \$87,638. The servers enhance network capacity via an internal-disk capacity of as much as 2.6 Gbytes and an external capacity of 236 Gbytes. All servers have two 8-Gbyte, 4-mm DAT (digital-audio-tape) drives, and a 600-Mbyte CD-ROM. You can stuff the main memory with 32 to 384 Mbytes of RAM.

Hewlett-Packard Co, 19310 Pruneridge Ave, Cupertino, CA 95014. Phone (800) 752-0900. Circle No. 737

Minimum Daily Requirement

Compact TOKIN Surface Mount Devices get you through the day with flying colors.

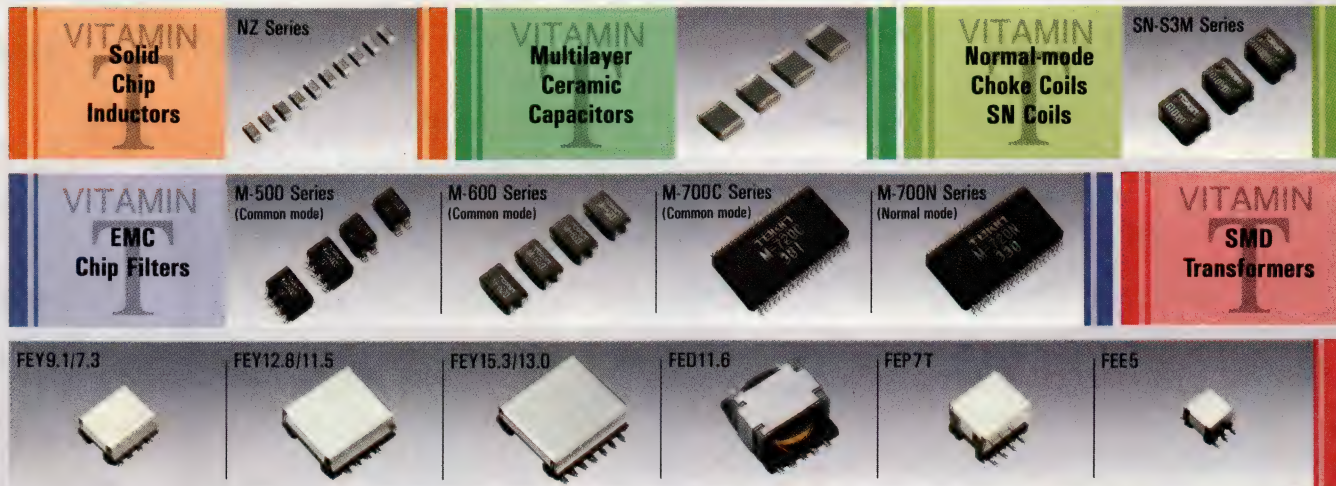


When you need something extra to get you through your next project, try a dose of TOKIN Surface Mount Devices (SMDs). Designed to provide maximum working room in tight spaces, TOKIN SMDs offer the ideal remedy for downsizing computers and other electronic or communications equipment and systems. What's more,

TOKIN SMDs come in a wide range of sizes to ensure you of the right formulation for your own special needs. EMC components—such as EMC Chip Filters and ultra-small Solid Chip Inductors

and SN Coils—counter noise emissions from compact, high-frequency power supplies, data terminals, personal

computers, and so on. SMD Transformers make for easy high-density mounting on a wide range of communications equipment. And High-capacitance Multilayer Ceramic Capacitors enable automatic mounting on PC boards. If you're not getting the SMDs you need to get you through the day, be sure to call TOKIN.



TOKIN

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Korea Representative Office
#602, Champs-Elysees Bldg., 889-5,
Daechi-Dong, Kangnam-gu, Seoul, Korea
Phone: (2) 569-2582 ~ 5 Fax: (2) 544-7087

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Phone: 508-875-0389 Fax: 508-875-1479

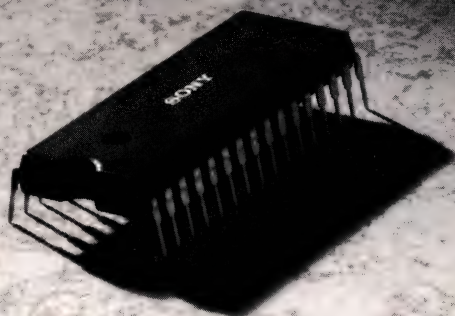
Tokin Electronics (HK) Ltd.

Room 806 Austin Tower, 22-26A Austin Avenue,
Tsimshatsui, Kowloon, Hong Kong
Phone: 367-9157 Fax: 739-5950
Taiwan Liaison Office
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Phone: (02) 7728852 Fax: (02) 7114260
Singapore Branch
140 Cecil Street, No. 13-01 PIL Bldg., Singapore
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Model	Speed (ns)	Package	Standby Current (μ A)	Special Features
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CXK581000M	100/120	SOP 525 mil	12/50	-25° - +85°C
				-40° - +85°C
CXK581100TM	100/120	TSOP	12/50	
CXK581100YM	100/120	TSOP (rev.)	12/50	
CXK581001P	70/85	DIP 600 mil	12/50	
CXK581001M	70/85	SOP 525 mil	12/50	
CXK581020SP	35/45/55	DIP 400 mil		
CXK581020J	35/45/55	SOJ 400 mil		
CXK581021J	47	SOJ 400 mil		
CXK581120J	15/17/20	SOJ 400 mil		
CXK77910J	20	SOJ 400 mil		Sync., 128K x 9

Note: All packages 5V, 32 pin, 128K x 8, unless otherwise noted.

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SONY

Computer-Aided Engineering

Autorouters For Unix Workstations

Pads-Force Routers use gridless technology and a shape-based data structure. Force Router I has a set of tools for SMD, PTH, and high-density designs. Force Router II adds tools that let you set trace pairs, balanced signals, signal-length matching, and layer restrictions. Both versions run on Sun SPARCstations. Force I, \$25,000; Force II, \$39,000.

Pads Software Inc, 119 Russell St, Suite 6, Littleton, MA 01460. Phone (508) 486-9521. FAX (508) 486-8217.

Circle No. 402



Standards Database Software

Standards Infodisk is a comprehensive bibliographic database of national and international standards on a CD-ROM disk. It covers more than 180,000 standards and specifications from more than 60 issuing authorities in the US, the UK, Germany, France, Canada, and Australia; it also includes standards from international bodies such as IEC, ISO, and CEN. The more than 40 US organizations covered include AIAA, AMS, AN, ANSI, ASHRAE, ASME, ASQC, ASTM, EIA, IEEE, IPC, MS, NEMA, SAE, and UL. More than two dozen European and international organizations are included. The product is a search tool that provides information for each standard and includes a title (in English), revision history, country of origin, subject

classification, and equivalent standards. When one standard refers to another, you can instantly access the second one with a "hot" key. The disk contains additional summaries of more than 50,000 standards; summaries of US industry standards specify whether or not the standard is acceptable to the US Department of Defense. Searches are in plain English; you can specify one or more parameters, including document number, title, revision date, country of origin, subject, or key word or phrase. To use the product, you need a PC XT, MS-DOS 3.0, and a CD-ROM drive. \$2195.

Document Engineering Co Inc, 15210 Stagg St, Van Nuys, CA 91405. Phone (800) 363-3647; (818) 782-1010. FAX (818) 782-2374.

Circle No. 403

Design-Synthesis Software

The Complete Optimization/Retargeting Environment (CORE) gives you the ability to select from a variety of FPGA technologies at any point in the design cycle. It accepts multiple design-entry methods, allowing you to use netlists, Boolean equations, and hardware-description languages singly or in combination. It accepts ABEL, CUPL, and MINC through PALASM; it takes Verilog HDL through a netlist format. From \$8000/seat.

Exemplar Logic, 2550 Ninth St, Suite 102, Berkeley, CA 94710. Phone (510) 849-0937. FAX (510) 849-9935.

Circle No. 404

IC-Design Software

Chiprafter 3.0 lets designers use performance criteria to determine a chip's physical layout. It features module libraries (with standard cells, memories, and data-path elements), fully automated place and route, and logic synthesis. This new



version offers open-architecture interfaces for the most popular CAE tools. From \$24,000.

Cascade Design Automation, 3650 131st Ave, Suite 650, Bellevue, WA 98006. Phone (206) 643-0200.

Circle No. 405

Linear-Circuit Analyzer

Analyser III analyzes designs for filters, crossover networks, wide-band amplifiers, antenna-matching networks, radio and TV IF amplifiers, chroma filters, linear integrated circuits, and more. It displays the frequency response of a circuit (from 0.001 Hz to tens of GHz), not only in terms of gain but also input and output impedances, phase responses, and group delay. \$375.

Number One Systems Ltd, Harding Way, Somersham Rd, St Ives, Huntingdon, Cambs PE17 4WR, England. Phone (0480) 61778. FAX (0480) 494042.

Circle No. 409

Parts-Selection Aid With Spice Models

The High Performance Selection Guide helps designers find the right Burr-Brown linear components for their designs. The guide comes on an IBM PC-compatible disk; it contains more than 1000 component models, an industry cross-reference section, sales-office listings, applications literature, and price and or-

dering information. This update of the guide contains more than 70 Spice models of the supplier's op amps, difference amps, and instrumentation amps. You can specify as many as 30 parameters when searching for a part. You can also search for parts without knowing a complete part number; type in a

partial number, and the search program will do the rest. New features include editing search parameters so that you don't have to re-enter them for every search. The disk lets you access 11 product categories: analog-circuit functions, analog-to-digital converters, digital-to-analog converters, dc/dc converters, in-

strumentation amplifiers, isolation amplifiers, multipliers, operational amplifiers, references, sample/hold amplifiers, and voltage-to-frequency converters. Free.

Burr-Brown Corp., Box 11400, Tucson, AZ 85734. Phone (800) 548-6132; (602) 746-1111. FAX (602) 889-1510. BBS (602) 741-3978 300/1200/2400 8,N,1. Circle No. 406

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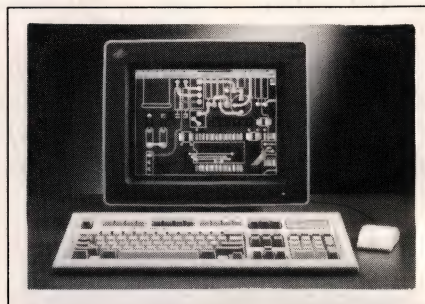
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CIRCLE NO. 92



DOS-Based Router

CADstar Advanced Router/DOS, a single-user version of a package that has been available for Unix, allows automatic routing of complex, high-density boards. The package features a fast, single-pass mode that lets you analyze potential routing success and a rip-up-and-retry algorithm for rerouting traces that can't be completed. A shove-aside algorithm moves traces aside to provide more room. \$2750.

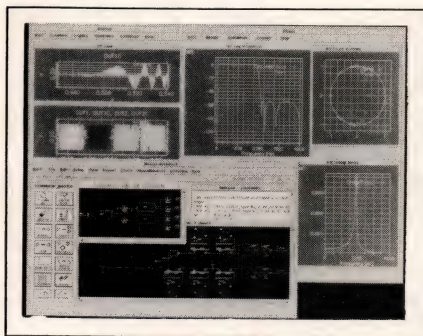
Racal-Redac, 238 Littleton Rd, Westford, MA 01886. Phone (508) 692-4900. FAX (508) 692-4725. TLX 948185. Circle No. 407

Bus-Design Timing-Analysis Tool

The Busdesigner/AT software tool reduces the hundreds of stringent timing specifications of the IBM AT, ISA, and EISA bus standards into a small group of requirements. The software lets a designer rapidly check a variety of architectures during a board's design stage. Once the designer settles on an architecture, the tool automatically generates timing diagrams complete with all timing margins for each type of bus

cycle. Timing models include I/O, memory with wait states, DMA cycle, memory refresh, and bus-master arbitration. The tool flags and highlights all timing violations, thus providing a design check before you build actual circuits or run complex simulations. You can change specific components and analyze the effects on the bus interface. Backplane propagation and clock-rate variables are available. Busdesigner/AT runs on top of the company's Timingdesigner graphical, interactive signal analyzer, which runs on PCs. Busdesigner/AT, \$695; Timingdesigner for Windows, \$995.

Chronology Corp, 2721 152nd Ave NE, Redmond, WA 98052. Phone (206) 869-4227. FAX (206) 869-4229. Circle No. 408



DSP Design System

DSP Station offers top-down DSP design, from high-level specification through simulation and optimization, into various physical implementations. It can generate assembly code for a commercial DSP chip; synthesize a design for a gate array or an FPGA; or create designs for standard cells, module generators, and configurable cores. It connects to the broader system of design tools in the Falcon framework. \$33,000.

Mentor Graphics Corp, 8005 SW Boeckman Rd, Wilsonville, OR 97070. Phone (800) 547-3000, Dept 109; (503) 685-8000. FAX (503) 685-8001. Circle No. 409

Fuzzy-Logic Design Tool

RT/Fuzzy aids the development and implementation of real-time software incorporating rule-based logic. An extension of the supplier's family of tools for graphical modeling, system design, simulation, and code generation, it simulates and generates code for fuzzy-logic designs. Fuzzy logic attempts to mimic imprecise human thinking by operating on IF-THEN statements that describe conditions and actions; it differs from conventional algorithms in that all rules are based on qualitative information rather than a set of procedural equations. The family of products that includes RT/Fuzzy provides for numerical algorithms, sequential logic, and fuzzy-logic rules in one design system. You can use it to address complex, dynamic control problems, for example, by combining rule-based reasoning with extensive numerical computation. You write fuzzy-logic rules in the conventional IF-THEN form; the IF condition can specify both fuzzy and real-valued inputs and outputs. You can enter membership curves as equations or data points and plot them on screen for visual verification. The software is available for Sun-4, SPARCstations, VAX, and HP workstations. From \$5000.

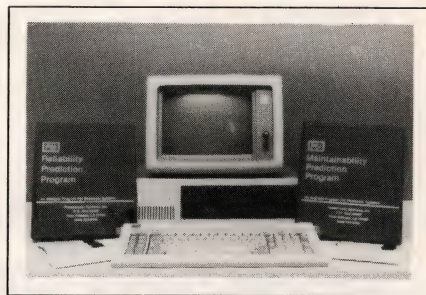
Integrated Systems Inc, 3260 Jay St, Santa Clara, CA 95054. Phone (408) 980-1500. FAX (408) 980-0400. Circle No. 410

Timing-Analysis Software

Racecheck, an addition to its supplier's Macromatrix gate-array design tools, is a dynamic-timing and test-vector-analysis design-automation tool. Developed jointly with Teradyne, it incorporates an encapsulated version of that company's Lasar V6 simulation system. The software models worst-case conditions both in circuit design and in the test-vector set. It's available on

SPARC and VMS systems and is bundled with the purchase of a gate-array development contract. From \$3000 for optional contract item.

Applied Micro Circuits Corp, 6195 Lusk Blvd, San Diego, CA 92121. Phone (619) 450-9333. FAX (619) 450-9885. Circle No. 411



Equipment-Reliability Prediction Program

Reliability Prediction Program RPP-5.0 predicts equipment reliability in accordance with the newly released MIL-HDBK-217F reliability handbook. The program implements both the parts-stress and the parts-count techniques of the new handbook. It produces reports that meet the requirements of military contracts. Single license, \$1700; site license, \$4800.

Powertronic Systems Inc, 13700 Chef Menteur Hwy, New Orleans, LA 70129. Phone (504) 254-0383. FAX (504) 254-0393. Circle No. 412

Switched-Capacitor Simulator

SCAP, a switched-capacitor simulator, is useful for filter and nonfilter circuits. For filter applications, it performs time-domain, frequency, aliasing, group-delay, sensitivity, spread, worst-case, charge-transfer, and noise analyses. In addition, by simulating circuits with arbitrary and data-dependent clocks, it is useful for the new telecom and digital-audio applications of switched-capacitor circuits. Integrated with its supplier's Explorer

Lsim mixed-signal, multilevel simulator, it runs concurrently with a variety of digital and analog simulation kernels. \$25,000.

Mentor Graphics Corp, 8005 SW Boeckman Rd, Wilsonville, OR 97070. Phone (800) 547-3000, Dept 109; (503) 685-8000. FAX (503) 685-8001.

Circle No. 413

Hardware Emulation System

RPMplus emulation system brings emulation to asynchronous and synchronous design styles. It emulates designs of as many as 50,000 gates and is compatible with its supplier's mRPM product, which emulates as many as one million gates. It can extract data from CAE designs

based on Verilog and Mentor Graphics tools, thus eliminating the need to use ASIC-vendor tools to generate an emulation netlist for each design change. From \$175,000.

Quickturn Systems Inc, 325 E Middlefield Rd, Mountain View, CA 94043. Phone (415) 967-3300. FAX (415) 967-3199.

Circle No. 414

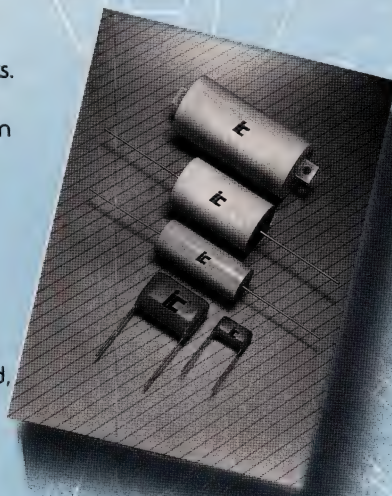
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- Low ESR and ESL characteristics
- Also excellent for EMI reduction, transient and snubber networks and other critical applications in place of polycarbonate capacitors

MPR/MPW/MPH capacitors are in stock for immediate delivery. MPL is special order. For complete details, contact your local IC distributor or IC.

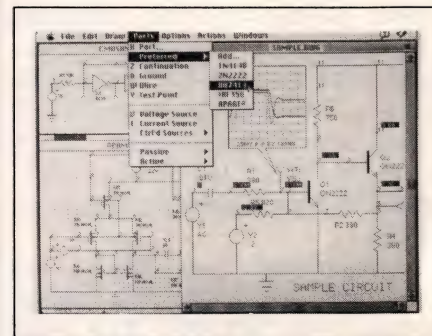
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3757 West Touhy Avenue
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708 675-1760
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CIRCLE NO. 130



Mac-Based Schematic Editor

With Spicenet v3.0M, you can add graphical schematic entry and editing to your Macintosh-based CAE system. The software displays post-processor waveforms and node voltages directly on the schematic; it generates a complete Spice 2G.6 netlist. \$445.

Intusoft, Box 710, San Pedro, CA 90733. Phone (310) 649-9099. FAX (310) 649-4503.

Circle No. 415

Radar Design System

The Radar Library option to the supplier's SPW (signal-processing workstations) lets you simulate, analyze, and optimize the design of radar systems before committing them to hardware. Radar models simplify the task of developing signal-flow diagrams; when you complete a flow diagram, you use SPW to simulate the effects of topology, component limitations, and other factors on signal propagation and system performance. \$3000.

Comdisco Systems Inc, 919 E Hillsdale Blvd, Foster City, CA 94404. Phone (415) 574-5800. FAX (415) 358-3601.

Circle No. 416



Tango®

the complete electronic design solution
from ACCEL Technologies, Inc.

specifications for DOS-based electronic design software

ACCEL Technologies' line of DOS-based, Tango software for electronic design automation (EDA) offers ease of use, performance and affordability for users of IBM PCs and compatible computers. Tango has built its reputation on providing highly productive design tools that offer quality and value to this large segment of design engineers.

We invite you to draw your own conclusions about Tango. Review the specifications on the following pages, check out any of Tango's full-function software evaluations and ask your friends for recommendations. We're confident you'll discover, like thousands of others, that Tango for DOS is a very capable workmate with unrivaled price/performance value.

Tango-Schematic (v1.3)

Tango-Schematic provides a wealth of features for quick creation of schematic diagrams and netlists on a PC. Tango-Schematic has extensive device libraries, containing *over 20,000* components. Using Tango's integrated, single-program approach, you create new components graphically -- with the same program as schematic sheets.

Product Highlights

- Windows™-like interface
- Supports both flat and hierarchical designs
- Supports commercial, DeMorgan and ANSI/IEEE symbols
- Extensive libraries cover a rich mix of technologies
- Wildcard searching in library browse
- Autopanning
- User-defined keyboard macros
- Integrated component editor and post-processors
- Post-processing includes forward- and back-annotation, design rule checking, sheet cleanup and netlist generation
- Excellent tutorial documentation and on-line Help system
- EMS support

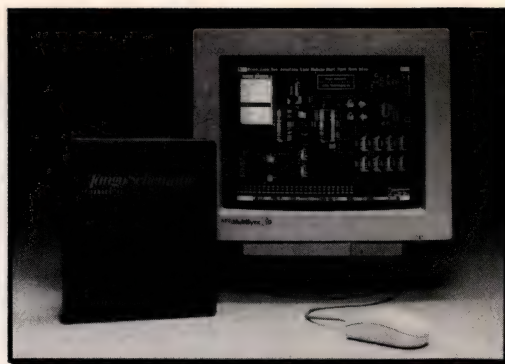
The program emphasizes versatility and functionality, with attention to details that set it apart from all other PC-based systems. For example, unlike other packages, Tango-Schematic supports both homogeneous components (multipart components where all parts must be the same) and heterogeneous components (multipart

components where parts may be different). This permits a relay's coil and contacts to be separated and placed at different points on a sheet, or even on different sheets.

Tango-Schematic's editing includes six line types (with orthogonal placement capability) user-definable sheet borders, title blocks and text sizes (from 1 to 1000 mils). Unlimited zoom levels, autopanning and our fast redraw make it easy to focus on any portion of your design. Designers may drag wires with components, display hidden power and ground pins, use a unique *snap-to-pin* feature (which guarantees correct wire-to-component connections) and rotate or mirror components and blocks.

The package supports ANSI A-E and ISO A4-A0 size schematic drawings with automatic scaling. If you run out of room in the middle of a design, just toggle up to the next size sheet, *without starting over*. Or create additional sheets -- up to 99 per level of hierarchy with a virtually unlimited number of hierarchy levels.

Other examples of Tango-Schematic's power include the ability to: extend net names across sheets to easily create multisheet designs; use multiple power and ground nets (for mixed analog and digital designs); place text horizontally or vertically stacked; and intelligently mirror text. Post-processing includes: netlist generation in a variety of popular formats; design rule checking; forward-



and back-annotation; and schematic cleanup.

Tango-Schematic produces crisp output on popular printers/plotters. Plus, you can generate DXF or PostScript files for use with compatible mechanical CAD, desktop publishing and word processing software.

Tango-Schematic is the front-end of a complete family of circuit design software. Common functions are executed within the same friendly user interface, putting an end to the time and trouble associated with learning a whole new look and feel for each program. ACCEL's commitment to independent, yet compatible, software packages gives you maximum flexibility plus all the benefits of an integrated system.

Tango-Schematic Specifications

- ❑ **Designs:** hierarchical or flat designs. Up to 99 sheets per level of hierarchy, up to 999 hierarchy levels.
- ❑ **Grid Sizes:** unique system of three grids (Absolute, Relative, Visible) in user-defined increments from 1 to 1000 mils.
- ❑ **Sheet Sizes:** ANSI A-E; ISO A4-A0.
- ❑ **Line Types:** wire; bus; line (thin or thick - solid, dashed or dotted).
- ❑ **Options:** lines may be placed in any of four orthogonal modes (45/90, 90/45, 45/45, 90/90), or non-orthogonal; drag wires with components; snap-to-pin; display hidden pins.
- ❑ **Zoom:** zoom all, center, extent, last, in, out, or window (user-definable by center or corners with unlimited zoom levels) jump to location, net, part, or text.
- ❑ **Autopanning:** pan horizontally, vertically or diagonally.
- ❑ **Text:** user-definable heights from 1 to 1000 mils with thickness automatically scaled to height; read left to right, or top to bottom (stacked), and fully rotated; optional barred text for pin names.
- ❑ **Title Blocks and Borders:** user-definable.
- ❑ **Component Libraries:** comprehensive libraries totaling over 20,000 parts: TTL and its various families; CMOS; ECL; microprocessors and peripherals; PLDs; linear ICs; transistors; diodes; connectors; electromechanical parts; and passive components. Standard commercial symbols, DeMorgan equivalents and ANSI/IEEE Std. 91-1984 support (complying with DoD design specifications). Library facilities include speed browse, list, merge, rename and PCB pattern indicator.
- ❑ **Component Creation:** integrated, graphical creation of new parts (both homogeneous and heterogeneous), with up to 255 parts per component; parts may include arcs, circles, rectangles, polygons, lines, text; full ANSI/IEEE Std. 91-1984 support.
- ❑ **Reports:** Bill of Materials with user-defined attributes, Parts Usage, Hierarchy Tree, Cross Reference, Library Contents, Part Locations and Last Used reports.
- ❑ **Keyboard Macros:** user-definable macros allow playback of a sequence of commands and cursor movements.
- ❑ **Block Options:** load/save, copy, move, rotate, delete inside, delete outside.
- ❑ **Post Processing:** generates Tango, EDIF 2.0, PSpice and PCAD netlists plus FutureNet netlist and pin list formats; performs design rule check (DRC); forward-annotation (combines gates to minimize component count, renumbers components); back-annotation (renumbers components from "was-is" list); fixes overlapping wires and combines collinear buses, lines, wires.
- ❑ **Miscellaneous:** autosave; component and block rotation and mirroring; intelligent mirroring of text; individual pins of a connector may be placed anywhere in the design; highlight a net when a net or pin is selected; function to automatically update parts from the library; support for multiple power and ground nets; standard or custom title blocks and/or borders; suspend to DOS.
- ❑ **Help Facilities:** on-screen Prompt Line, over 100 screens of context sensitive on-line Help with index.
- ❑ **Reference:** 350+ page illustrated manual with Tutorial, Reference, Command Summary, Glossary, Index.

Output Options

- ❑ **Plotters:** Hewlett-Packard (HPGL) and Houston Instruments (DMPL), CalComp (PCI), Roland DXY-800.
- ❑ **Printers:** Epson FX/LQ, IBM ProPrinter, Okidata, Star Micronics, Toshiba, HP LaserJet, HP PaintJet, HP DeskJet, Apple LaserWriter, other PostScript printers.
- ❑ **PostScript:** PostScript files (both normal and encapsulated).
- ❑ **DXF:** Data Interchange Format (DXF) files.
- ❑ **Options:** print or plot with title and/or border turned on or off; automatic scaling of drawing to the sheet size selected; multicolor plots and prints; automatically print all sheets in a hierarchical design.

Tango-PCB and Tango-PCB PLUS (v2.1)

Design high-quality, multilayer printed circuit boards with Tango-PCB or Tango-PCB PLUS software. Tango's powerful, easy-to-use design tools have brought *tens of thousands* of boards to life.

Tango-PCB Highlights

- User-defined lines, pads, arcs, polygons, text, grids
- Autopanning and unlimited zoom levels
- User-defined keyboard macros
- Editable PWR/GND planes
- Automated aperture assignment
- Electrical rule check
- Metric conversion assist
- Accepts netlists from Tango, OrCAD, Schema and others
- Includes libraries of standard and SMT parts
- Outputs to printers, pen plotters, photoplotters and N/C drills
- Excellent documentation and On-line Help

Tango-PCB PLUS adds:

- Mechanical rule check
- Four additional mid-layers, for a total of 23 layers
- Component auto-placement
- Force vectors for component placement assistance
- Photoplot file viewer
- DXF file output
- PostScript output
- EMS support

Tango's ergonomic user interface is the standard for ease-of-use and productivity. Menus, dialog boxes, user-defined macros, a versatile zoom, autopanning plus "Hot Spots" and "Speed Palette" all combine to form a powerful design

environment suited for new users and seasoned pros alike.

The packages include standard component libraries and SMT patterns. Creating new components is simple: just draw them on the screen without ever leaving the PCB Editor.

Components may be *Moved, Mirrored, Rotated* and *Released* into their individual primitives, (pads, lines, etc.). Powerful global editing operations are accomplished with a single mouse click.

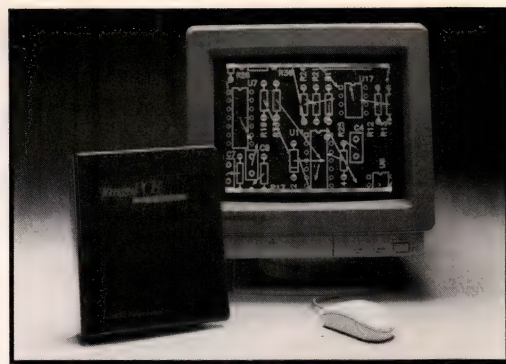
Both PCB packages accept netlist input from Tango-Schematic, OrCAD/SDT, Schema and other popular systems. Nets may be displayed as a *ratsnest* of connections, quite useful as a placement aid. Connections can be *rubberbanded* when moving components for easy re-routing.

Auto-via placement speeds the multilayer signal routing. Editable power and ground planes and polygon fill aid analog design. Tango-PCB's *Block Operations* include Load/Save, Copy, Move, Rotate, Delete inside or outside with filters on layers and items.

Both Tango packages generate a netlist and *back annotate* to Tango-Schematic and OrCAD/SDT.

Tango assists with component placement in three ways: 1) components can be placed manually, interactively or automatically; 2) a ratsnest display aids placement and manual routing; 3) force vectors (available in PCB PLUS) emanating from components provide assistance in placement optimization.

Design verification tools (multilayer check plots and



prints) plus Tango's electrical verify operation ensure proper connectivity. An integrated DRC in Tango-PCB PLUS adds a check of the physical clearances (including minimum hole clearances) on the board against a user-defined set of design rules.

PCB PLUS' photoplot file viewer permits an on-screen preview of the photoplot files generated with Tango, providing you with a high measure of confidence prior to photoplotting.

In PCB PLUS, artwork files may be generated in the Drawing Interchange Format (DXF) for input to popular mechanical CAD programs such as AutoCAD.

Tango-PCB PLUS supports up to 8 or 32 Mbytes of expanded memory conforming to the LIM EMS 3.2 or 4.0 standards. EMS enables you to design larger, more densely packed boards.

In Tango-PCB PLUS, PostScript PCB files may be used to generate final artwork for typesetting machines (such as the Linotronic Series) with the quality of a photoplot but at lower cost. They can also be used with desktop publishing or word processing for design documentation.

Generate final artwork on pen plotters, dot matrix printers, and photoplotters. We have taken the mystery out of photoplotting with clear instructions, sample files and automated aperture assignment.

Tango-PCB/Tango-PCB PLUS Specifications

- ☐ **Resolution:** 1 mil.
- ☐ **Grids:** unique system of three grids (Absolute, Relative, Visible) in dotted or hatched styles and in user-defined increments from 1 to 1000 mils plus metric conversion assist.
- ☐ **Maximum Size:** 32 x 32 inches.
- ☐ **Layers:** 23 total layers, including six Signal layers (ten in PLUS); Power & Ground Planes; Keepout, Board Outline, Connections, Title, Drill Drawing layers; Top & Bottom Silkscreen, Assembly, Solder Mask layers.
- ☐ **Line Sizes:** user-definable from 2 to 250 mil.
- ☐ **Pad Sizes/Shapes:** user-definable sizes from 2 to 4000 mils, hole diameters from 0-250 mils; multiple shapes (round, ellipse, rectangle, rounded rectangle, oval, mounting hole and target).
- ☐ **Text:** user-definable sizes from 4 to 1000 mils (height), and 2-250 mils (line width).
- ☐ **Arcs:** user-definable size, line width, starting point and ending point; may be placed on any layer.
- ☐ **Keyboard Macros:** user-definable macros allow playback of a sequence of commands. Includes a set of default macros.
- ☐ **Netlist Support:** accepts Tango-format netlist from Tango-Schematic, OrCAD/SDT, Schema, others. Displays ratsnest; force vectors; optimizes nets; verifies all nets or one net at a time; and generates a Tango-format netlist; restores connection information for deleted routes.
- ☐ **Back Annotation:** creates a was/is list of reference designators which can be read by Tango-Schematic and OrCAD/SDT.
- ☐ **File Previewing:** on-screen view of photoplot files (in PLUS only).
- ☐ **DRC:** conducts complete electrical and user-defined clearance check on entire design (clearance check PLUS only).
- ☐ **SMT Support:** top and bottom component placement/mirroring, SMT libraries, fine-line trace widths, variable pad and grid sizes, Top & Bottom Silkscreen, Assembly, and Solder Mask layers. Paste Mask generation.
- ☐ **Polygons:** polygon support allows arbitrarily-shaped filled areas with up to 255 sides on any layer. Edit command permits shape changes.
- ☐ **Autopanning:** pan horizontally, vertically, or diagonally.
- ☐ **Block Options:** load/save, copy, move, rotate, delete inside, delete outside. User-selectable by item and layer.
- ☐ **Component Placement:** provides manual placement (PLUS adds interactive and automated component placement functions) with automatic incrementation of reference designators. Force vector display (PLUS only) and ratsnest also aid optimized placement.
- ☐ **Component Libraries:** includes libraries of standard through-hole and surface mount patterns. Graphical creation of new parts, plus library facilities such as browse, sort, list, merge and rename.
- ☐ **Reference Manual:** 400+ page manual with Tutorial, Reference, Command Summary, Glossary, Index.
- ☐ **Help Facilities:** on-screen "Prompt Line", plus over 100 screens of context sensitive on-line Help with Index.
- ☐ **Miscellaneous:** autosave; editable power and ground planes; an automatic aperture

assignment option; unique "Title Layer"; built-in ruler function; hardcopy reports including: Aperture Listing, Bill of Materials, Component Locations, Library Contents, PCB Components, PCB Statistics.

Output Options

- ☐ **Photoplots:** Gerber format.
- ☐ **PostScript:** PostScript format (PLUS only - in normal and encapsulated formats).
- ☐ **DXF:** Design Interchange Format (DXF) for transfer to AutoCAD and other popular mechanical CAD programs (PLUS only).
- ☐ **N/C Drills:** Excellon format.
- ☐ **Plotters:** Hewlett-Packard (HPGL), Houston Instruments (DMPL), CalComp (PCI), Roland DXY-800.
- ☐ **Plot Types:** draft or final quality artwork for all Signal layers; Power & Ground planes; Keepout, Board, Connections, Title, Drill Drawing, Padmasters; Top & Bottom Silkscreen Overlays, Assembly Drawings, Solder Masks, Paste Masks.
- ☐ **Printers:** Epson FX/LQ, IBM ProPrinter, Okidata, Star Micronics, Toshiba, IDS, HP LaserJet, HP PaintJet, HP DeskJet printers.
- ☐ **Print Types:** the same as plot types, including draft and final quality artwork for any layer.

Tango-Route and Tango-Route PLUS (v2.0)

Tango-Route and Tango-Route PLUS are productive, yet affordable, circuit board autorouters. When used with the corresponding Tango PCB layout editor and Tango-Schematic (or other schematic entry package), Tango-Route provides tremendous productivity advantages over manual routing.

Tango-Route Highlights

- **Multipass routing algorithms for speed and high completion**
- **True 90-and 45-degree routing for higher-density designs**
- **Pre-routes and keep-outs**
- **Routes on a 25-mil grid with off-grid capability**

Tango-Route PLUS adds:

- **True multilayer routing: adds four additional signal layers (to match PCB PLUS' ten) plus power and ground planes**
- **Fine-line capability and improved SMT support**
- **Five routing grids (from 10-25 mils) for multiple traces between ICs (including SMDs) with off-grid capability**
- **EMS support**

Using Tango-PCB or Tango-PCB PLUS, the board outline is defined, components are placed and any critical connections may be *pre-routed*. *Keep-out areas* are also easily defined. The partially completed PCB file and its associated connection information are then handed over to Tango-Route. During setup, Tango-Route's easy-to-use pop-up menus allow any of the routing passes to be toggled on or off, thus configuring the autorouter to the particular design at hand. Sensible defaults make setting up the menus even easier. To save

time, a setup file is saved for each board design.

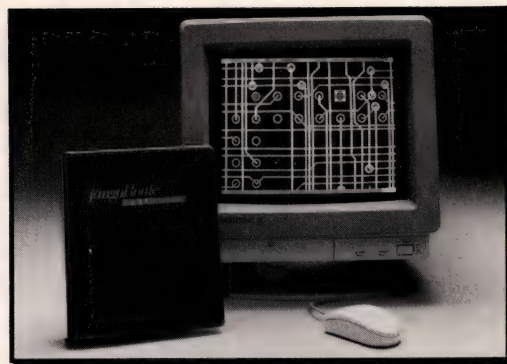
Both *proprietary and maze routing strategies* are used to achieve the dual goals of speed and high completion rates. Wide-net routing is available for power/ground connections. Unrouted lines are left in the connection layer of the board in a *ratsnest* format and listed in a log file to aid manual completion in Tango-PCB.

Tango-Route subjects all pre-routed connections to a thorough *design rule check* for clearance and electrical violations. The user can define any clearance value from 1 to 13 mils. Next, Tango-Route optimizes the netlist and begins routing connections. The user may zoom and pan a graphical display of the routing process, while a continuously updated status line reports progress towards completion.

Final optimization passes include *via minimization* and *trace cleanup* which eliminate any unnecessary vias and improve board manufacturability, thus reducing costs. The log file, generated during the routing process, shows statistics on the design rule check and each routing pass.

Tango-Route PLUS is a *true multilayer router*, meaning any and all enabled layers may be used for completing a route, as opposed to the more common "layer-pair" technique where the router will only use a pair of layers for any given connection.

On a 20 MHz '386, Tango-Route typically autoroutes a full-size IBM plug-in card containing 90 equivalent ICs (EICs) in approximately 20 minutes, achieving 85% completion. A



board with 25 EICs, two signal layers and a density of .77 square inches per EIC routes to 100% in 2.5 minutes.

Tango-Route PLUS has demonstrated its high-completion autorouting capabilities on a 25% analog 75% digital benchmark board. Using a 20 MHz 386, Tango-Route PLUS finished its route of this densely-packed 9 x 9.7 inch board with 133 equivalent ICs, four signal layers and one track between pads to 100% completion in just under six hours.

Tango-Route/Route PLUS Specifications

- **Maximum PCB:** 32x32 inches
- **Routing Grid:** 25-mil grid with off-grid capability (PLUS has five routing options - 25, 20, 16.7, 12.5 and 10 mils with off-grid capability)
- **Routing Strategies:** wide trace, proprietary and maze
- **Layers:** two signal layers plus power/ground plane (PLUS version has ten signal plus power/ground plane)
- **Design Rules:** pad-to-pad, line-to-line and pad-to-line clearances specified on a layer-by-layer basis.
- **Routing Report:** a complete routing report is generated
- **Documentation:** thorough reference manual featuring Tutorial, Reference, Commands, Error Messages, Glossary and Index plus on-line Help.

Tango-Route PRO (v1.0)

Tango-Route PRO is a high-performance autorouter for extremely fast, high-completion of printed circuit boards. Tango-Route PRO's speed, completion rate and features make it the most powerful autorouter running on IBM-PCs and compatibles.

Product Highlights

- **Unique "reconstruct" algorithm iterates toward 100% completion faster than all other PC-based autorouters**
- **Intelligent algorithms produce high-quality designs**
- **Multipass methodology applies unique routing algorithms to specific tasks**
- **Easy-to-use Tango interface**
- **Automated operation selects best routing configuration**
- **Uniform and non-uniform routing grids enhance performance, and allow freedom of placement**

Tango-Route PRO offers a unique reconstruct autorouting algorithm for high completion of all current PCB technologies, including multilayer, through-hole and SMD. Designers will typically experience routing which is 20% to 300% faster than comparable PC-based autorouters. Intelligent manufacturing-improvement algorithms ensure high yields, lower costs and enhance board aesthetics.

Route PRO uses a three-phase, multipass methodology, comprising constructive, iterative (remove and re-place) and manufacturing passes. Yields in manufacturing are improved with fewer vias and shorter total trace lengths. Other functions performed by the manufacturing passes include spreading and cleanup of tracks, removal of acute angles and improved pad entry.

Tango-Route PRO combines Tango's popular interface, user-selectable options plus "expert system" automation to provide easy access to its powerful capabilities.

Tango-Route PRO analyzes board, placement and user-defined design rules. By selecting its automated operation method, Tango-Route PRO determines the best routing grid(s) and passes, via grids, and layer directionality.

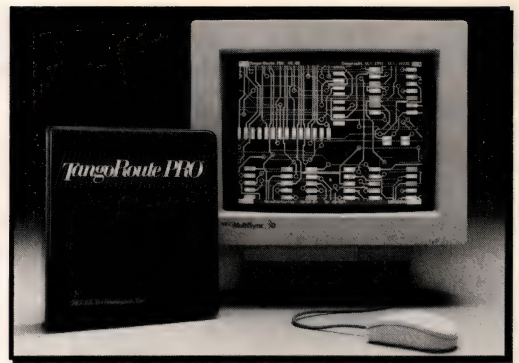
Achieving results previously available only with gridless routers, Tango-Route PRO supports uniform *and* non-uniform routing grids, which enables it to handle virtually any board density and any combination of design rules and pad sizes. Tango-Route PRO solves localized blockage problems by also routing off-grid, as required.

Other features include: advanced SMD support; true diagonal routes; set track widths on a net-by-net basis; copper share (T-routes); user-defined clearances on an individual layer basis (Pad-to-Pad, Line-to-Line and Pad-to-Line); simultaneous routing on all enabled layers (not just on layer pairs).

Tango-Route PRO performs user-specified file backup and provides on-line and report file routing status on line and in a report file.

Tango-Route PRO Specifications

- **Router Type:** multiple routing passes in three phases: Constructive phase includes SMD, Wide Trace, Initial, Comprehensive and Exhaustive passes; Iterative (remove and re-place) phase includes up to 10 Iterative passes; Manufacturing improvement phase includes up to 10 Manufacturing and one Final Manufacturing passes. Iterative and Manufacturing



passes use the reconstruct algorithm, removing obstructing traces and intelligently replacing them to increase completion and reliability.

- **Resolution:** 1 mil.
- **Maximum PCB Board:** 32 x 32 inches.
- **Maximum Components:** 4,000
- **Maximum # Connectors:** 256
- **Maximum # of Nets:** 5,000
- **Layers:** ten signal layers, one power and one ground plane plus board, connections and keepout layers.
- **Routing Grids:** uniform (100; 50; 25; 20; 16.7; 12.5; 10; and 8.3 mils) and non-uniform (42-16-42; 42-8-8-42; 40-20-40; 40-10-10-40; 38-12-12-38 and 17-16-9-8-8-9-16-17) plus off-grid routing when required.
- **Design Rules:** pad-to-pad, line-to-line and pad-to-line clearances specified on a layer-by-layer basis.
- **SMT Support:** user-defined line widths, pad and vias sizes, design rules; smart via fanout; optimal pad entry; SMD pads on top and bottom layers; and unlimited SMD pitch.
- **Routing Report:** a complete routing report is generated
- **Documentation:** thorough reference manual featuring Tutorial, Reference, Commands, Error Messages, Glossary and Index plus on-line Help.

Tango-Susie

Susie brings interactive logic simulation to desktop engineering. Its timing-driven, functional simulation allows you to bypass tedious hardware bread boarding.

Product Highlights

- **Menu-driven input, graphical waveform output**
- **Eliminates compilation of test vectors, allows correction of design problems on-the-fly**
- **Glitch Mode instantly shows any potential design faults**
- **Very fast: program and models written in assembly language**
- **Accepts netlists from Tango, OrCAD, Schema and others**
- **Full documentation including tutorial and on-line help**

Susie includes a graphical test-vector editor for test vector creation. Quickly tweak signals or duplicate entire sections of timing.

Design glitches may be further evaluated using the optional timing interactive module (Tim), that provides timing simulation down to 10 picoseconds. Tim allows you to change propagation delays or even chip technology on-the-fly.

Specifications

- **Operation:** interactive functional simulation, glitch detection, optional timing simulation to 10 picoseconds.
- **Capacity:** 20,000 gates (640K).
- **Speed:** 17,000 events/per second (8MHz AT).
- **Timing:** average unit propagation delays (Susie); or user-selectable propagation delays (Susie + Tim).
- **Libraries:** TTL, ECL, CMOS, switches, passives, plus Model Builder for creating new models; optional libraries also available.
- **Output:** logic analyzer display (up to 1000 signals) and printed output, waveform or ASCII.

Tango-BETAsoft

Tango-BETAsoft or "Board-level Electronic Thermal Analyzer" is a thermal-reliability software tool for printed circuit design, that allows you to beta test board hardware during design.

With many differing IC technologies, the highest IC junction temperatures may not correspond to the highest failure rates. Use BETAsoft to identify alternatives which can increase quality and board-level efficiency, cut the overall cost of manufacturing product and reduce failures.

Product Highlights

- **Features both thermal (junction temperature) and MTBF reliability analysis**
- **Provides broad, user-definable testability**
- **Displays color-coded map of thermal analysis and reliability results**
- **Analyzes up to 600 components per side**
- **Provides rapid computation**
- **Uses 3-Dimensional modeling on complex flow and thermal fields**
- **Fully Tango-PCB compatible**

The reliability analysis software evaluates all microelectronic component design using the MIL-HDBK-217E standard. Reliability data of microelectronic components are included in the component library and the program easily creates library data based on component functionalities.

The thermal analysis program, gives an accuracy of 3 degrees C (validated by wind-tunnel/infrared image tests and users). Analysis can be performed on components with heat sinks and irregularly-shaped boards. Results in a sealed



compartment or in an open system with horizontal or vertical orientation can be simulated. The flow field can be set for natural, forced or combined convections and the board can be located at the edge or interior of a cabinet.

Tango-BETAsoft versions: two-sided (includes support for up to 600 components on each side of a two-sided board) and one-sided (which analyzes up to 600 components on a single-sided board design).

Specifications

- **Thermal Fluid Models:** 3-D
- **Max. No. of Components/Component Types:** 600 per side/400 per board
- **Types of Components:** SMD and through-hole
- **Component Attachments:** heat sinks and conduction pads
- **Component Library:** 2,500 provided, plus user-created parts
- **Board Types:** PWB, etc. with or without metal core
- **Board Shapes:** rectangular or irregular
- **Board Property Complexity:** non-homogeneous, anisotropic
- **System Configuration:** open or sealed; horizontal or vertical
- **Convection Types:** natural, forced or combined
- **Reliability Standard:** MIL-HDBK-217E compatible
- **Reliability Data Base:** All microelectronics and R, C
- **Output:** most printers and plotters

Tango-Schematic Xilinx Support

The Tango-Schematic Xilinx Support Package allows you to design Xilinx field-programmable gate arrays (FPGAs) using Tango-Schematic. It includes libraries of components in Tango-Schematic format which represent the primitives for the Xilinx LCA 2000, 3000 and 4000 Series FPGAs. Also included is a utility to translate Tango-format netlists into XNF-format netlists which can be imported in the Xilinx development system.

The translator supports the advanced features of "hard macros" in the LCA 4000 Series. The Tango package also uses external symbol templates, which will allow it to incorporate features introduced into future LCA products.

The package does not include specific provisions for feeding information on the design to simulators but these may be created and then added to the XNF netlist using merge utilities provided with the Xilinx XACT development tools. "Soft macro" logic may also be easily drawn in Tango-Schematic and integrated into the design.

To help the user understand the Tango/Xilinx design process, the package includes numerous sample schematic designs. Also included are part templates for each of the 2000 and 3000 Series' FPGA components, in PLCC, DIP or PGA pinouts for placement on a system-level schematic once the entire FPGA design is complete.

OrCAD-to-Tango Translation Assist

This assist package has been developed to aid in the translation of OrCAD/SDT schematics to Tango-Schematic designs. The package is comprised of two utility programs which combine to give you complete schematic translation capability.

The O2TLIB utility is a library component editor for both standard and custom components and the O2T utility assists in translating schematic sheets. The OrCAD-to-Tango assist package helps to assure that your heavy investment in custom libraries and designs will not be lost when switching from OrCAD/SDT to Tango-Schematic. It allows users to maintain their schematic designs in the Tango format and use Tango's friendly interface for redesigns.

SMT Land Pattern Book

This easy-to-use book is a compilation of approximately 275 surface mount device (SMD) and component land patterns. Specifications are based on hundreds of successfully manufactured designs and/or sound engineering principles.

The Professional SMT Component and Land Pattern Book is a valuable resource in successfully designing for surface mount technology (SMT). Patterns are optimized for high-density designs. The book is the most widely sold in the United States. Author Jim Blankenhorn is one of the industry's acknowledged experts in the area of design using surface mount technology.

Although no guarantees for manufacturing yields can be made, the land patterns in this book are endorsed by the International SMT Association and are the only such patterns to receive this level of certification from the ISMTA. These land patterns have a worldwide proven track record for use in producing high-quality, high yielding assemblies.

The handbook provides a valuable guideline for the SMT designer seeking improved SMT results.

Specifications

- ☐ JEDEC, EIA, EIAJ parts for SOIC, SOT, SOJ, VSO, PLCC, TAB, Sockets, Trimmers, Chip Resistors and Capacitors, Flat Packs, Connectors, Tantalums, Inductors, JLCC, LCC, Oscillators and more.
- ☐ Military and commercial packages, wave solder optimized patterns, TAB in 10 - 20 mil pitch to over 800 leads on a part.
- ☐ Softbound book containing a plot of each pattern, its mechanical dimensions and relevant comments regarding its use.

System requirements

Listed below are the basic requirements for all Tango brand DOS-based software:

- ☐ **Computer:** IBM PC/AT/PS2/386/486 personal computers & compatibles, 640K RAM, hard disk, parallel port
- ☐ **Operating system:** PC-DOS or MS-DOS Version 3.3 or later
- ☐ **Graphics support:** includes EGA; VGA; TIGA; Hercules monochrome; Orchid ProDesigner PLUS and ProDesigner II 800x600, 1024x768; ATI VGAWonder 800x600; ATI VGAWonder XL/VGA Wonder Ultra 800x600, 1024x768; Genoa 5400, 6400; 800x600, 1024x768; Headland/Video 7 640x480, 720x540, 800x600, 1024x768, VRAM II 1024x768; Paradise 800x600; Fahrenheit 1280. In addition, Tango includes a configurable, generic video graphics driver that supports virtually any video graphics card up to and including 800x600
- ☐ **Mouse:** Microsoft Mouse or equivalent (recommended but not required)
- ☐ **Diskette size:** Tango software is shipped in the user's choice of 5.25" (1.2Mb) or 3.5" (1.44Mb) floppy diskettes

The following are *options* or *exceptions* to Tango system requirements:

- ☐ **EMS** - up to 8 Mbytes of expanded memory with LIM EMS 3.2 or 32 Mbytes with LIM EMS 4.0 (optional) is supported for use with Tango-Schematic, Tango-PCB PLUS and Tango-Route PLUS
- ☐ **Tango-Route PRO** requires a 386-based PC with a math coprocessor (387) or a 486-based PC; Tango-PCB or Tango-PCB PLUS; and a minimum of 8M of RAM

Product updates and maintenance

All Tango software ships with a 30-day, money-back guarantee. ACCEL Technologies provides 90 days of free product updates and technical support for all products. Also, offered is Tango Total Support (TTS), an annual, per-license program of unlimited product updates and technical support via fax, BBS, our toll-free 800 telephone line and the *TangoToday* quarterly newsletter. (TTS is not available outside of North America. Product guarantees, updates and technical support offerings vary by country. Check with your Tango representative.)

Educational support

ACCEL Technologies offers an educational discount on full versions of its Tango products to schools and colleges. In addition, Tango/e, a specially designed, deeply discounted suite of Tango tools, is available for educational use. Comprised of full-function, modified versions of Tango-Schematic, Tango-PCB PLUS, Tango-Route PLUS, Tango-PLD and Tango-Susie, Tango/e versions come with complete documentation and are ideal for classroom and lab use. Call Tango Sales or your nearest Tango representative for more information.

Free functional evaluation packages available

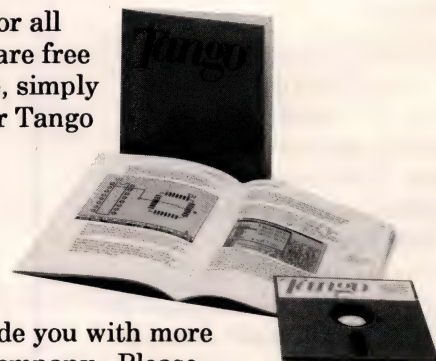
ACCEL Technologies offers free full-function software demo packages for all products. These evaluation copies include tutorial documentation and are free upon request to qualified designers. To receive any evaluation package, simply call our toll-free line, **800 488-0680**, in the U.S. or Canada, contact your Tango representative or fill out the accompanying Info Request card.

More...

ACCEL Technologies welcomes your inquiries. In addition, authorized Tango sales representatives, located world wide, would be glad to provide you with more information or talk to you about setting up a product seminar at your company. Please feel free to contact us if you have questions or would like the name of the Tango representative nearest you.

All product specifications and system requirements are subject to change without notice.
For pricing information, call ACCEL Technologies.

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COMPUTERS AND PERIPHERALS

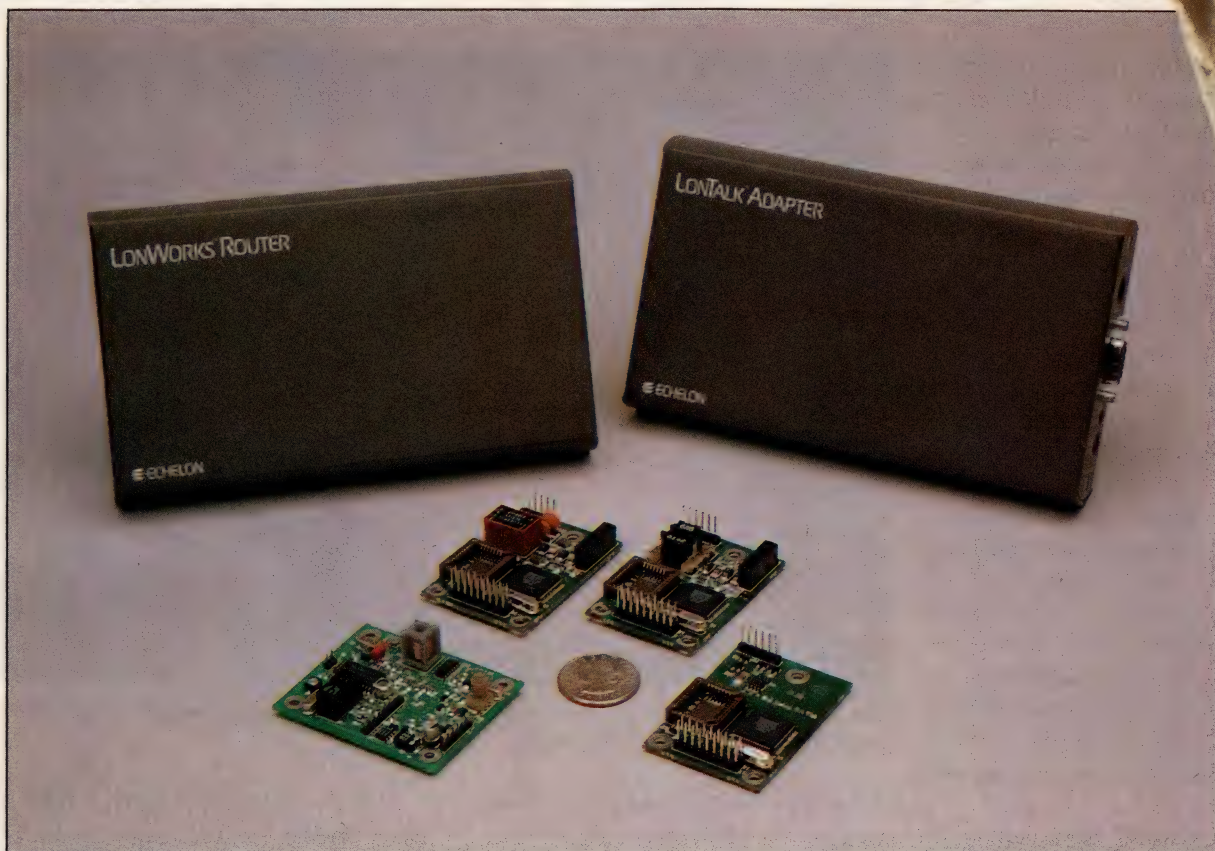
LOW-COST CONTROL LANs ADD AUTOMATION TO HOMES, AUTOS, AND OFFICES

MAURY WRIGHT, Technical Editor

From smart houses to industrial automation, control LANs now provide standard protocols and software interfaces to simplify development of automatic distributed control applications.

EMERGING DISTRIBUTED CONTROL NETWORKS will shortly end a situation where a plethora of applications have waited for reasonably priced remote- and automatic-control technology. Specifically, products based on Echelon's Lonworks or on the EIA (Electronics Industries Association) CEBus (consumer electronics bus) will make applications such as a totally automated "smart house" feasible. The two control-LAN technologies address communications media, network protocols, and application-software hooks—all requisites for standard multivendor low-cost control systems.

Distributed control networks connect a variety



of devices such as lights, switches, and sensors to create an automated environment. Industries regularly use such systems to sense light or temperature and control equipment accordingly. But most industrial-control LANs use expensive and proprietary technology that limits their use in smaller industrial applications, in homes, and in offices. CEBus and Lonworks promise to make such control technology available in low-cost off-the-shelf products from multiple vendors (see **boxes** for background on the two LANs).

Applications for control LANs vary from simple lighting control to industrial-equipment control to replacing the spider-web of wiring in automobiles. A home or office lighting application could consist of sensors that turn lights on when a person enters a room. A more elaborate control LAN

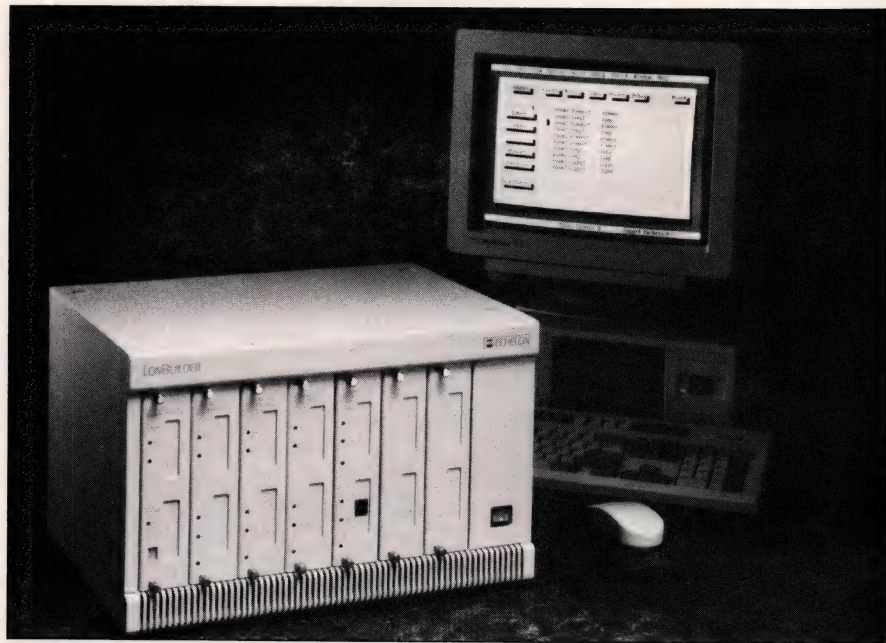
including RF transceiver units and modules that include both Neuron chips and twisted-pair transceivers, Echelon's Lonworks products allow you to quickly design and build a Lonworks LAN.

might also use a dimmer to set the appropriate light level based on ambient lighting from outside.

An even better example of an office application involves an eye doctor's office. The doctor has an array of instruments that surround an examination station, and each instrument requires different lighting for the eye test to proceed properly. Eye doctors must manually adjust the lighting between each test. A control LAN could automatically adjust the lighting level based on the doctor removing an instrument from its holster or activating the power to the instrument. The LAN might also be used to control visible indication of the status of each examining room—for example, a series of colored lights that indicate "vacant," "patient waiting for doctor," or "examination in progress" status.

You can extend the idea of an automated office to include control of heating and air-conditioning systems, security systems, and any other part of the physical plant of an office. A control LAN can be used in a car to handle all of the sensor and control needs normally connected with dedicated wires. A single LAN, for example, could connect all sensors, such as fuel and oil level, and control the dashboard. The same LAN could provide heating and air-conditioning control, automatically turn headlights on at night and off when you park, control automatic door locks, and handle the car security system.

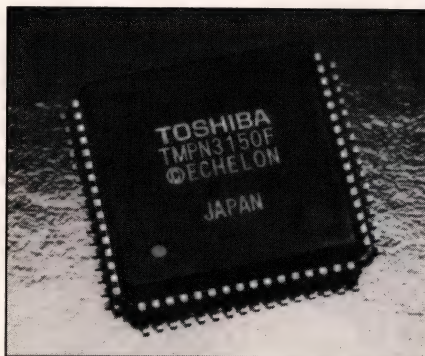
Control LANs will offer benefits to end users ranging from luxuries for consumers to time- and money-saving devices for businesses. The technology also provides a number of benefits to design engineers. You may find, for example, that the control LANs discussed here allow you to solve a design problem that you couldn't solve before. Or, perhaps more likely, you may use them to



The development system for Lonworks LANs allows you to develop Neuron C applications and test the code on operating nodes.

solve a problem using a much lower-cost design than you could have produced before.

The technology will also open the door for entrepreneurs. Expect companies to spring up that operate as a service business providing custom-automation designs for business and consumer needs. Likewise, companies will surely offer standard building-block products such as light sensors and controllers based on the Lonworks and CEBus technologies.



Neuron chips from Toshiba and Motorola include three processors: ROM and RAM memory, an interface to I/O devices, and the network transceiver interface.

Strictly speaking, control LANs don't enable you to design products and systems that you can't design using standard LANs. But control LANs allow you to do the designs at much lower end-user cost and much more quickly. In fact, applications such as a smart house aren't economically feasible without control-LAN technology.

Control LANs operate entirely differently from traditional dedicated control circuitry. Consider lighting control in a house or an office. Traditionally, the ac signal that powers the light in a room must physically pass through an on-off or dimmer switch before connecting to the light fixture. Lighting switched by a control LAN requires no such direct physical connection.

LANs provide logical links

A control LAN provides a logical connection between a switch and a light fixture. Though you must connect the switch and the light fixture to nodes on the control network, the new LANs offer a variety of ways

to make such a connection. Both Lonworks and CEBus allow multiple types of communications media that you can use to connect all nodes on a network. And you can bridge different media types in a single installation.

Imagine a house-wiring scheme that might use twisted-pair wire to connect nodes at each light-switch bank and thermostat. AC power lines required to power a light fixture would also carry network sig-

nals to the control node built into the fixture. A handheld TV-style remote-control node could connect to the control LAN via an infrared link. Light and temperature sensors inside and outside the house would connect through various media. And a master controller would bridge the media and provide programmability for the system.

Logical connections to a light fixture in such a house would provide a number of ways to switch or dim

the light. The local switch would still work. You could program the master controller to switch the light at various times. Or you could control the light from the remote control or set it to respond to sensors.

CEBus targets the home

The CEBus committee specifically designed the control network for use in and around the home. You can also expect CEBus to find its way into offices, but probably not

Lonworks concept encompasses all seven network layers

Echelon set out to design a complete distributed control LAN when they conceived their local operating network (LON). The overall Lonworks concept includes communications medium, network communications protocols, and the application software interface that makes the technology easily usable. Ultimately, the key to Echelon's success will be that it also designed ICs that make Lonworks nodes feasible, network-management tools that simplify the use of Lonworks LANs, and development tools that allow designers to get products to market quickly.

The Lonworks Lontalk protocol supports as many as 32,385 nodes in a single "Domain" or network. The protocol allows you to structure a domain into groups and subnetworks to simplify network design. The LAN implements media-access control (MAC) using a modified version of the CSMA (carrier-sense multiple-access) algorithm called Predictive P-Persistent CSMA. The algorithm reduces the bandwidth degradation due to collisions found in other CSMA LANs such as Ethernet. Lontalk can handle data transfers as fast as 1.25 Mbps, but actual transmission-rate and cable-length limits depend on the physical communications media used in a specific installation.

The Lonworks concept is essentially media independent. Echelon has discussed plans to offer network transceivers for a variety of media including twisted-pair wire, coaxial cable, optical fiber, RF transmission, infrared signaling, and transmission on ac power lines. Currently, Echelon offers only twisted-pair and RF transceivers, although Echelon and third parties should have other options available later this year. Designers can mix and match media in a single domain using network bridges.

Each Lonworks node requires a Neuron chip. The

Neuron chips actually include the network-protocol controller as well as an application processor. In fact, each Neuron chip includes three separate processors (**Fig 2**, main article, depicts the chip architecture). The MAC processor handles network channel allocation and data transfers. The network processor takes care of communication between nodes and maps network variables to variables used in the local application code. And the application processor executes the application program. The chips also include varying amounts of ROM and RAM, interfaces to I/O devices, and the network interface that connects to the transceiver of choice. Motorola and Toshiba manufacture the Neuron ICs.

Neuron C handles interoperability

The final piece of Lonworks is the Neuron C application language. Based on ANSI C, Neuron C includes extensions to the language for the Neuron chip and the Lonworks LAN. Key added features include

- a new class of objects, "network variables," that simplify the sharing of data among nodes
- a new statement type, the "when" statement, that introduces "events" and defines the temporal ordering of these events
- explicit control of I/O operations, through declaration of "I/O objects," to standardize multifunction I/O specific to Neuron chips
- support for explicit message passing used for direct access to the underlying Lontalk protocol services.

Specifically, the Lontalk protocol includes a predefined set of SNVTs (standard network variable types). The SNVTs provide the links between network variables in application programs on different nodes and therefore key the distributed control operation.

into any industrial applications. Lonworks will fit home, office, automotive, and industrial applications.

Expect to see CEBus products emerge this year. You can already buy an IC from Intellon that can send and receive CEBus signals over ac power lines. Called the SSC PLCE, the IC uses spread-spectrum technology to communicate. Fig 1 depicts the IC in a block diagram. The IC costs less than \$5 (25,000), and Intellon sells a set of six samples for \$300. The company also offers an evaluation board for \$105 and a 3-node CEBus evaluation system for \$3495. Expect an infrared CEBus-compliant IC from Intellon later this year.

Now that the CEBus is defined,

the real key to its success will come as manufacturers of consumer electronics add CEBus to their products. Judson Hofmann, chairman of the CEBus committee and vice president of Panasonic Technologies, claims that the committee expected audio/visual applications to appear first, but power companies have been the most aggressive potential users thus far. The power companies would like to install CEBus nodes in home power meters and in major appliances to perform load management and remote metering.

Hofmann also expects software products to debut soon that will allow designers to develop CEBus application programs easily using

CAL (common application language). But designers ready now need only standard microcontroller (μ C) development tools. Hofmann reports that the committee kept the CEBus protocols simple enough that a μ C such as the 8051 can handle network communications and execute application programs.

Comparing CEBus to Lonworks, you will find a few key differences that might guide your choice for a specific application. The adjective high-cost certainly doesn't fit Lonworks nodes, but each node does require a Neuron chip that currently costs around \$10. The use of a standard μ C for CEBus nodes should make such a node lower in cost. In fact, CEBus node cost will

CEBus targets home applications

With all of the electronic goodies in use around your house, you've probably wondered why they can't all communicate and interoperate. Interoperability of audio/visual equipment was the driving force that instigated the development of the CEBus (consumer electronics bus—commonly pronounced "see-bus"). The standards committee decided they might as well add support for things like power and lighting control, security systems, and appliance control if they wanted a complete CEBus. And today the basics for the bus are in place.

A committee working under the auspices of the EIA (Electronics Industries Association) CEG (Consumer Electronics Group) developed the CEBus standard. According to CEBus Committee Chairman and Panasonic Technologies Vice President Judson Hofmann, standards for the physical, data-link, and network layers are complete. The CEBus can use infrared, twisted-pair telephone wire, cable-TV coax, ac power lines, or RF media. The control LAN uses a CSMA (carrier-sense multiple access) channel-allocation scheme and PWM (pulse-width modulation) encoding. The encoding yields a maximum rate of 10 kbps, if all bits are a "one," but usually less speed depending on the data pattern.

Hofmann relates that the committee worked to make the protocol as simple as possible because consumer applications will demand low price. Hofmann claims that a microcontroller such as the Intel 8051 can execute

both the LAN protocol and the application program.

The CEBus standard also makes available a data channel on other free network resources. For example, a CEBus operating over cable-TV coax could use the 10-kbps control channel to negotiate the use of one of the cable-TV channels as a data channel. More succinctly, a CEBus-compliant security camera connected to a home cable coax could, on command from your infrared CEBus-compliant TV remote control, send video on a channel you are not watching on your CEBus-compliant TV or recording on your CEBus-compliant VCR to the second tuner in your picture-in-picture TV.

CAL (common application language) handles the interoperability among CEBus nodes. Conceptually, the CEBus committee defined CAL with a "kernel" that includes language features such as syntax, protocol, and packet structure. Various feature sets called "contexts" implement commands in the language for specific types of CEBus-compliant products. According to Hofmann, the committee has finished contexts for audio/video and ac-power applications, and the lighting-control context is under development. But Hofmann and the committee would like to allow groups directly related to other specific industries, such as security systems, to develop contexts for their industry. And Hofmann admits that CAL will never be 100% finished because someone will always find a new type of product requiring a new context.

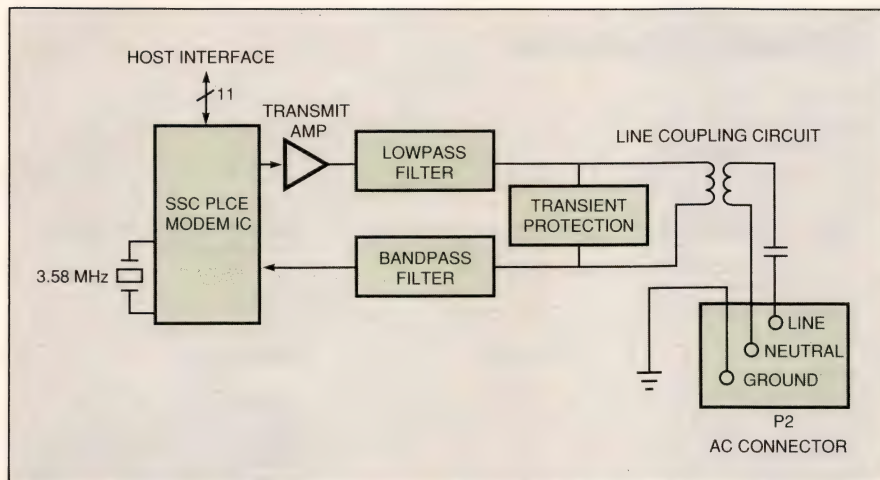


Fig 1—AC power lines will play key roles as control-signal carriers in new control LANs. Intellon's SSC PLCE IC targets ac-line transceiver applications in CEBus LANs. The company also plans to offer a Lonworks version.

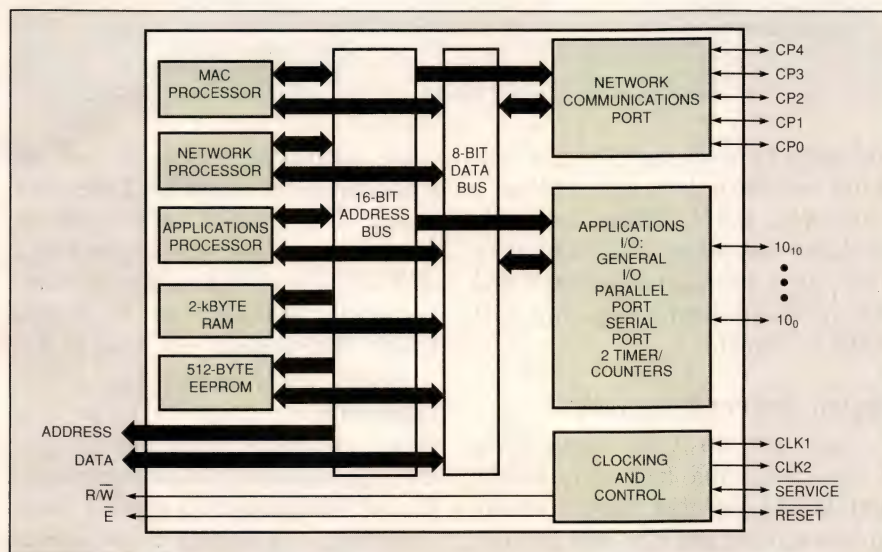


Fig 2—Neuron ICs include a MAC processor that handles channel control, a network processor that ensures interoperability of Lonworks nodes, and an application processor that executes the Neuron C code.

allow manufacturers of most consumer products to justify adding CEBus into their products.

The CEBus architecture makes provisions for using a data channel along with the 10-kbps control-LAN channel. For example, CEBus signals can run over cable-TV coax while the coax still carries TV signals. CEBus allows nodes to negotiate use of the coax to send video over unused channels.

CEBus allows similar resource

sharing for other media, such as sending control packets and voice over twisted-pair phone wires. Although Lonworks can transfer data at 1.25 Mbps—substantially faster than CEBus—Lonworks LANs do not include separate data channels.

Lonworks and CEBus also approach the application software issue slightly differently. Lonworks uses an enhanced version of the C language called Neuron C for application programs. Lonworks nodes

establish logical connections via network variables. In a new network design there is little or nothing that you can't accomplish from the distributed-control viewpoint. You simply write the software to handle the control application.

The CEBus CAL language, however, makes it feasible for different companies to offer off-the-shelf compatible consumer products. In a CEBus-compliant environment, a consumer would fully expect to be able to use a remote control to pop up a window on a TV to adjust a thermostat—even if the consumer bought the products from different manufacturers at different times.

Designers that think Lonworks will fit a new application have an impressive array of development tools and products to choose from. Furthermore, designers familiar with μ C-based design and the C language can design operating Lonworks control LANs in days.

Each Lonworks node is based on a Neuron IC. Echelon's IC partners, Motorola and Toshiba, both offer the chips in the same two flavors. The 3150 IC, as shown in Fig 2, includes 2 kbytes of RAM and 512 bytes of EEPROM in addition to three processors and I/O. The 3120 has 1 kbyte of RAM, 512 bytes of EEPROM, and 10 kbytes of ROM, and can address 42 kbytes of external memory. Both Motorola and Toshiba quote prices of \$10 (5000) for the chips.

Prices to drop quickly

But Motorola Lonworks Product Manager Al Mouton believes prices will drop quickly to below \$5 in a year and to \$2 by 1995. And a typical Lonworks node doesn't need much more than the Neuron IC. The node needs only a transceiver for the medium of choice and the sensor or control component required for the node's application.

Echelon offers small modules that

COMPUTERS AND PERIPHERALS

include a Neuron IC and a twisted-pair transceiver. The price for the modules varies from \$65 to \$90 based on the transmission speed and cable distance your application requires. The available transceivers include a 1.25-Mbps model that can handle 500m cable lengths and a 78-kbps model that works with cable runs as long as 2000m. Prices for the modules drop to \$50 or less in 500s quantities.

Echelon also offers an RF transceiver that can transfer data at 4.9 kbps and costs \$95. Other available products include routers, repeaters, and bridges. Expect other transceiver types from Echelon and third parties later this year. For example, Intellon has announced that it intends to offer a version of its spread-spectrum ac-power-line transceiver for Lonworks.

You can also already buy a chip that expands the I/O capability that Neuron ICs offer. The EIOC chip from Microsym interfaces directly to the Neuron IC and is designed to implement other auxiliary interfaces, such as serial communications as fast as 19,200 bps, keyboards, magnetic card readers, and real-time clocks. The IC also provides additional memory-mapped I/O space.

Echelon offers many development products, but prices are on the high side. If you plan to design Lonworks LANs, first you have to buy a \$2500 license to the Neuron technology. Echelon will sell you evaluation products before you buy the license, but you'll need a license to incorporate the technology in a product. The \$2500 license fee is probably insignificant if you plan to use Lonworks in saleable products, but it may add significant cost to 1-time custom designs.

A must for most new Lonworks users, the Lonbuilder Starter Kit will set you back \$17,995. The kit does, however, include everything

you need to start designing, developing software for, and testing a Lonworks LAN. Other assorted products that allow you to add more nodes to a prototype network and test different media typically cost \$1000 to \$2000.

Design centers lower cost

Don't give up if the entry price is too steep. Motorola and Toshiba both have Lonworks design centers spread around the US, and you can arrange with a Neuron IC salesman to use tools at one of the design centers. Motorola, Toshiba, and Echelon have also been regularly presenting Lonworks seminars and training classes around the country.

The companies behind Lonworks seem positioned for success. No other technology offers you the opportunity to design distributed-control systems ranging from 10 nodes in a house to thousands of nodes in a factory at such a low end-user cost.

Third parties are already jumping on the bandwagon. Ziatech offers STD Bus-based boards that in-

clude Lonworks nodes, as well as a PC ISA bus-compatible Lonworks board. The Ziatech boards can be used in development applications and in roles such as network-management stations in deployed LANs. The boards cost \$395 each.

Action Instruments has added Lonworks compatibility to its line of I/O products for industrial-control applications. The first product, the AP5050 paperless remote chart recorder, can record 2700 events and sells for \$325. The \$300 AP5900 network manager allows you to connect the remote chart recorders to a central computer, and a \$195 software package provides on-screen displays of the recorded events. Action plans to add Lonworks nodes to other sensor and control products for fall introduction.

EDN

For more information . . .

For more information on the control-LAN products discussed in this article, circle the appropriate numbers on the Information Retrieval Service card or use EDN's Express Request service. When you contact any of the following manufacturers directly, please let them know you read about their products in EDN.

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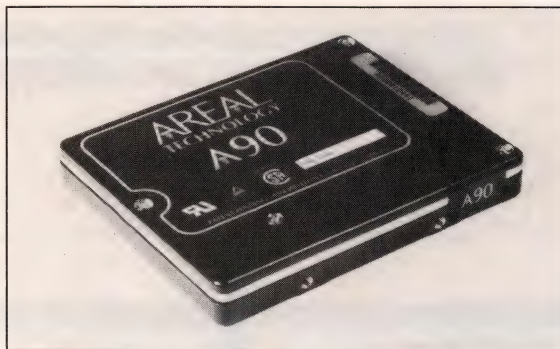
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2.5-in. disk drive packs 91.5 Mbytes into a 0.5-in.-high package

The A90 2.5-in. hard-disk drive stores 91.5 Mbytes on a glass disk in a package 11.7 mm (0.46 in.) high. The 3.4-oz drive operates with 386- and 486-based notebook computers or card-level storage subsystems. The linear density of the glass disk is 70,659 bpi; its track density is 2764 tpi. In addition, the glass disk is highly resistant to damage from nonoperational shock. The disk drive can withstand a nonoperating shock as high as 125g for 11 msec. The drive can withstand an operating shock of 20g.

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endure more contact-stop cycles than their aluminum counterparts. The unit can withstand a minimum of 50,000 power-on/power-off cycles. Other features include a 15-Mbps transfer rate, 2981-rpm rota-

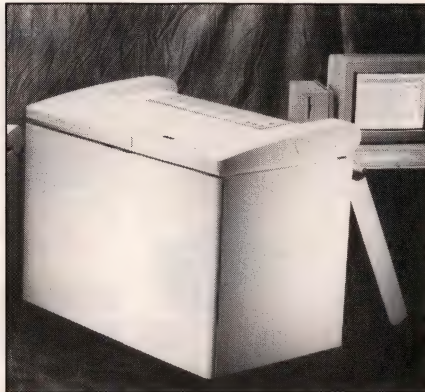
tion rate, 14-msec average access time, and a sector servo. \$365.

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The Colorstation 400X family of electrostatic plotters produces color or monochrome E-size (36×50-in. cut-sheet) or D-size (24×36-in. cut-sheet) drawings. The series comprises four models: the Colorstation 436CX for E-size color drawings; the Colorstation 424CX for D-size color drawings; the 436MX for E-size monochrome drawings; and the 424MX for D-size monochrome drawings.

The plotters boast a writing speed of 6 ips—considerably faster than competitive models, which write between 0.8 and 2 ips. The units achieve their speed by em-



ploying a patented Silicon Imaging Bar writing head. Conventional electrostatic plotters employ a multiplexed writing head to transfer

electrical charge to the medium. The writing head consists of a dedicated driver for each nib. Because a multiplexed driver necessitates a time delay before applying charge to subsequent nibs, it is slower than these dedicated drivers.

The plotters' hard-disk drives come in 42-, 100-, or 234-Mbyte sizes. Prices range from \$22,895 to \$44,895, depending on disk-drive option.

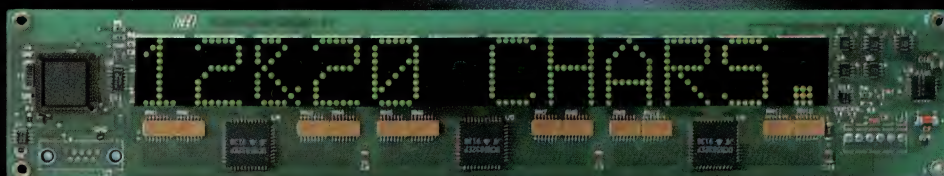
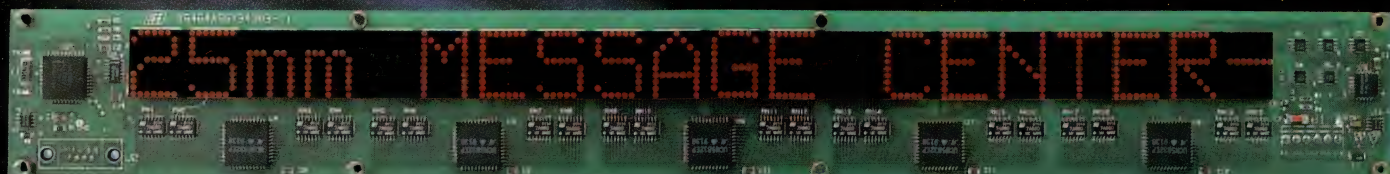
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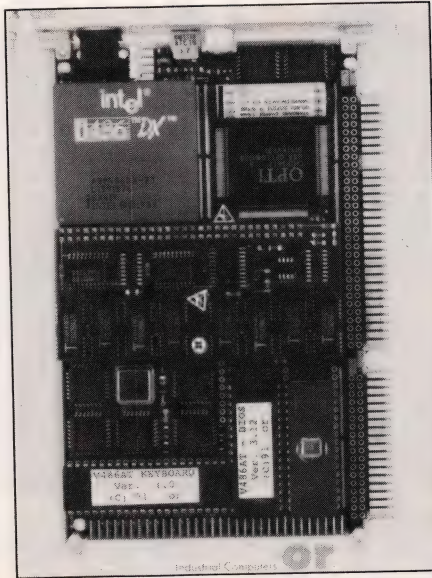
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VMEbus 3U board brings 80486 μ Ps to industrial applications

The V486 VMEbus board incorporates an 80486 μ P and suits rugged industrial applications. The 3U board comes in two versions: One has a 20-MHz 486-SX, and the other has a 33-MHz 486-DX μ P. The CMOS board draws 1.2A and operates from -25°C to $+85^{\circ}\text{C}$. It comes with 1, 2, 4, or 8 Mbytes of dynamic RAM (DRAM); 16- and 32-Mbyte versions are under development.

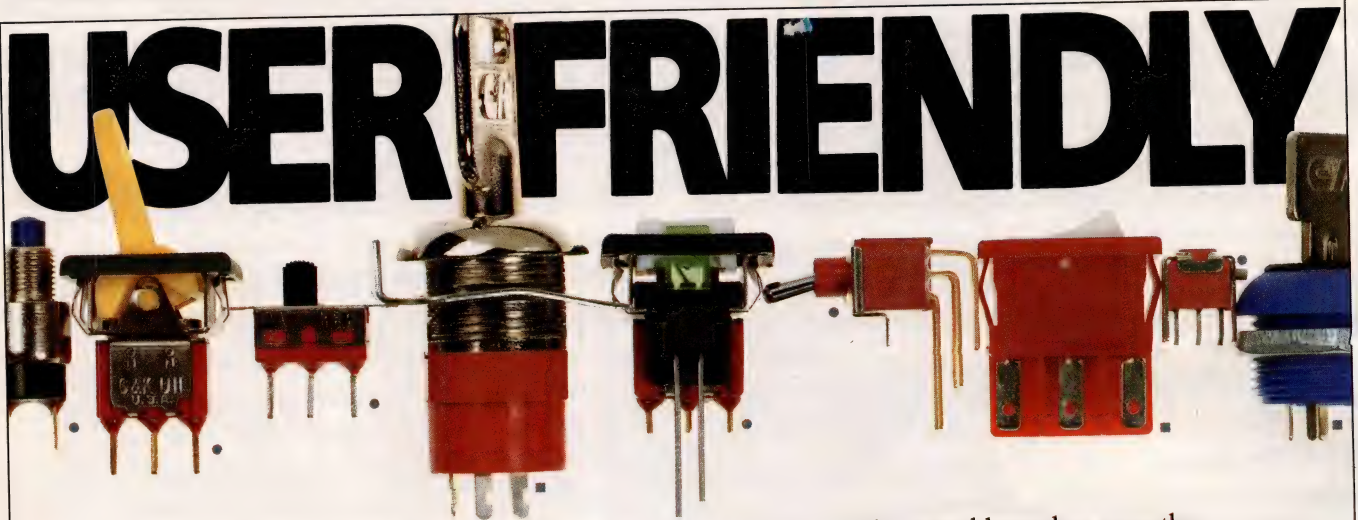
The board conforms to the EMS 3.2 and EMS 4.0 extended-memory-support standards. RAM shadowing provides for fast BIOS access. You can install as much as 1 Mbyte of flash ROM, which the BIOS will



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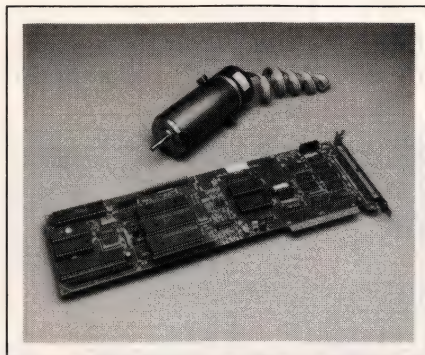
Acromag Inc, Box 437, Wixom, MI 48393. Phone (313) 624-1541. FAX (313) 624-9234. Circle No. 360

Motion-Controller Boards

The DMC-6X1 Series consist of 1-, 2-, and 3-axis motion-controller cards for the ISA bus. The cards feature linear and circular interpolation to coordinate motion in 2-D. You can specify as many as 255 linear or circular segments, and the cards accept quadrature encoder inputs as fast as 2×10^6 counts/sec. You can also synchronize multiple axes to a master axis using an elec-

tronic gearing mode. You can even change the gear ratio on the fly.

The cards can latch the position of each axis within 20 nsec. The cards have eight programmable inputs and eight programmable out-



puts that permit synchronized motion to external events. Other features include a programmable PID (proportional-integral-differential) loop filter with feedforward acceleration, S-curve profiling, $\pm 10V$

output-voltage range, and 12-bit output resolution. Single-axis DMC-611, \$995; 2-axis DMC-621, \$1495; 3-axis DMC-631, \$1995.

Galil Motion Control Inc, 575 Maude Ct, Sunnyvale, CA 94086. Phone (408) 746-2300. FAX (408) 746-2315. Circle No. 361

Embedded Single-Board Computer

The SBX-C186EB is a 16-bit single-board computer for embedded applications. The stand-alone board runs at 8 or 16 MHz and contains an Intel 80C186EB μP and an 80C187 coprocessor. You can install a maximum of 512 kbytes of static RAM and 512 kbytes of EPROM or flash EPROM. Other features include an 8570 real-time calendar clock, an interrupt controller, five 16-bit counter/timers, 32 parallel

Power tools

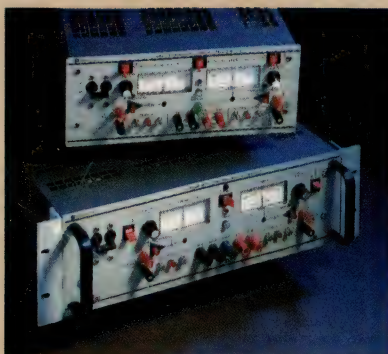


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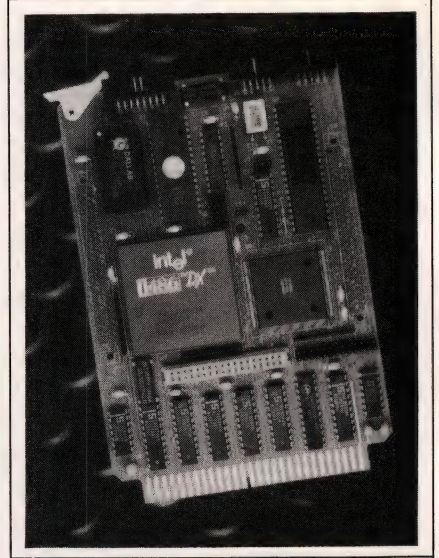
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BIOS in a protected area of the flash EPROM. You can develop software for the computer using Borland C++ or assembly code. The 8-MHz version, \$425; 16-MHz version, \$465.

R L C Enterprises, 4800 Templeton Rd, Atascadero, CA 93422. Phone (805) 466-9717. Circle No. 362



80486 STD Bus Single-Board Computers

The MCM-486DX and MCM-486SX are STD bus boards. The MCM-486DX contains a 25- or 33-MHz 80486DX μ P, and the MCM-486SX contains a 20- or 25-MHz 80486SX μ P. The cards contain as much as 8 Mbytes of dynamic RAM (DRAM) and the Mosel MS401 32- or 64-bit data-path chip, which creates an effective 64-bit-wide memory-bus data path via automatic data interleaving. The effective 64-bit data path permits burst-read and post-write operations in one clock cycle.

Other features include two serial RS-232C/RS-485 ports; a parallel printer port; a keyboard controller; a battery-backed calendar clock; a DMA and interrupt controller; three 16-bit timer/counters; and a watchdog timer. The cards automatically sense and switch to either 8- or 16-bit data transfers to memory or I/O cards on the STD Bus. The cards run MS-DOS, OS/2, and QNX operating systems. The 20-MHz MCM-486SX with 1-Mbyte DRAM, \$1995; the 25-MHz MCM-486DX with 4-Mbyte DRAM, \$2995.

Winsystems Inc, Box 121361, Arlington, TX 76012. Phone (817) 274-7553. Circle No. 363

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Embedded Controller Board

The QED Board 3½×4-in. embedded controller board contains an 8- or 16-MHz Motorola 68HC11 μ C (microcontroller). It has eight timer-controlled digital I/O ports; eight analog-input channels that feed the μ C's 8-bit A/D converter; eight analog-input channels that feed a 12-bit A/D converter; and eight analog-output channels driven from an 8-bit D/A converter.

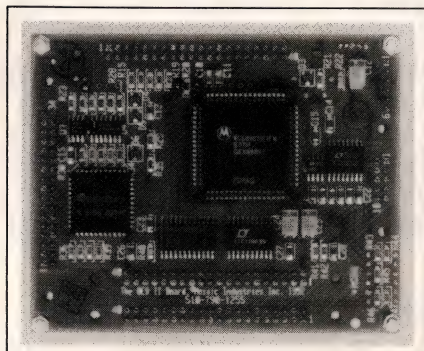
In addition, the board has dual RS-232C/RS-485 serial ports; as much as 384 kbytes of battery-backed RAM or ROM; and a keyboard and display connector. A 64-kbyte ROM contains a high-level Forth language; floating-point and matrix-math library; memory manager; multitasking real-time kernel;

nal transceiver; and an AT command set.

The transceiver has 832 channels and a sensitivity of -116 dBm. The phone features a 3W output-power level; an alphanumeric memory scan; 115 memory locations; call-in progress protection; automatic redial; a call timer; and a backlit key-

pad. The unit connects to laptop computers via a cable, and an internal rechargeable NiCd battery allows mobile communications. Data link, \$1799; optional ac power pack, \$50.

Microcom Inc, 500 River Ridge Dr, Norwood, MA 02062. Phone (617) 551-1000. **Circle No. 365**



in-line assembler; and symbolic debugger. The board operates on a 6- to 12V-dc supply and draws 100 mA. \$395 (100).

Mosaic Industries Inc, 5437 Central Ave, Newark, CA 94560. Phone (510) 790-8222. FAX (510) 790-0925. **Circle No. 364**

Cellular Data Phone

The CDL 300 cellular data link consists of a modem housed in a Mitsubishi Model 1500TPK cellular telephone. It uses the MNP 10 error-correction algorithm and transmits data at 9600 bps. The modem provides V.42bis data compression; conformance to V.22, V.22bis, Bell 103, and Bell 212A standards; autoanswer and autodial; an inter-

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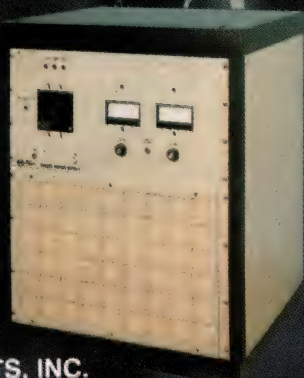


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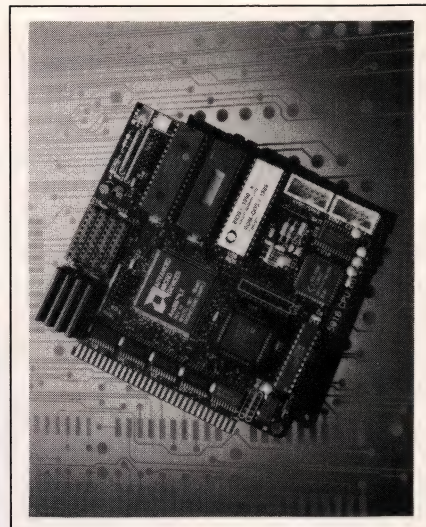
CIRCLE NO. 98

Industrial ISA Bus Single-Board Computer

The 5016A Micro PC is an 8-bit ISA bus single-board computer for industrial applications. It employs a 16-MHz 80C286 μ P that runs an embedded DOS 3.31 operating system. The card measures 4.5 \times 4.9 in., operates from -40 to +85°C,

and can withstand 5g vibration and 20g shock.

Other features include a 4-Mbyte dynamic RAM (DRAM); COM1 and COM2 ports; a parallel printer port; three solid-state disks consisting of a 2-Mbyte RAM or EPROM and 1.5-Mbyte nonvolatile memory; an EPROM programmer; a watchdog



timer; a calendar/clock; and a coprocessor socket. You can remotely download programs via an RS-485 link and store them in nonvolatile memory. The card works with the LIM 4.0 standard for extended memory beyond 640 kbytes. \$521 (100).

Octagon Systems Corp, 6510 W 91st Ave, Westminster, CO 80030. Phone (303) 430-1500. FAX (303) 426-8126. Circle No. 366

Multimedia PC

PORTABLE desktop

Built-in 9-1/2" 1024 x 768 SVGA Color CRT Display
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Standard Features:

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- 120 MB IDE H.D.D. up to 500 MB available
- 1.2 MB F.D.D. and 1.44 MB F.D.D.
- 2 Serial / 1 Parallel Ports
- 16-Bit 1024 x 768 SVGA Card with 1 MB RAM
- 101-Key detachable Keyboard
- MS DOS 5.0
- Nylon Carrying Bag
- Optional CD ROM / Tape Backup / Removable H.D.D. / Multimedia Kit
- We custom build each computer to your specifications

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CIRCLE NO. 95

SBus FDDI Adapter

The CMC-950 is an SBus FDDI (fiber-distributed-data-interface) adapter for Sun's SPARCstations. The single-slot card creates a single-attachment station on an FDDI network. The adapter employs a 128-kbyte buffer and two DMA channels, which minimize host-processor overhead. The adapter performs 32-bit data transfers on the SBus and features 64-byte bursts. Resident software includes the Simple Network Management Protocol agent and Station Management 6.2 to manage ring operations. A link-level binary driver for the SunOS 4.1.1 operating system comes with the adapter. \$2595.

CMC, 125 Cremona Dr, Santa Barbara, CA 93117. Phone (800) 262-8023; (805) 968-4262. FAX (805) 968-6478. Circle No. 367



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VM3200

3.3-VOLT, TWO-TERMINAL THIN-FILM/MIG HEAD READ/WRITE PREAMPLIFIER

FEATURES

- High Performance
 - Read Gain = 300, 200 or 150 V/V
 - Input Noise = $0.55\text{nV}/\sqrt{\text{Hz}}$ Typical
 - Head Inductance Range = $0.2 - 5\ \mu\text{H}$
 - Write Current Range 5 - 25 mA
 - Input Capacitance = 22pF Typical
- Improved Write Voltage = 5 Vp-p Diff. Typical
- Very Low Power Dissipation = 1.8 mW Typical in Sleep Mode
- Power Up/Down Data Protect Circuitry
- Single Power Supply = $3.3\text{ V} \pm 10\%$
- Fault Detect Capability
- Designed for Two-Terminal Thin-Film or MIG Heads
- Standard Schottky - Isolated $400\ \Omega$ Damping Resistor (patent pending)

DESCRIPTION

The VM3200 is a high-performance, very low power read/write preamplifier designed for use with two-terminal thin-film or MIG recording heads. This circuit will operate on a single 3.3-volt power supply and is ideal for use in battery-powered disk drives.

The VM3200 provides write current switching in the write mode and a low noise data path in the read mode for up to four read/write heads. When deactivated, the device enters a **sleep mode** which reduces power dissipation to 1.8 mW. Data protection circuitry is provided to ensure that the write current source is totally disabled during power up/down conditions. Write-to-read recovery time is minimized by eliminating common mode output voltage swings when switching between modes. Write mode performance is improved by providing 5-volt differential peak-to-peak head voltage, which allows the write current to swing faster.

The VM3200 is available in 2 or 4 channels.

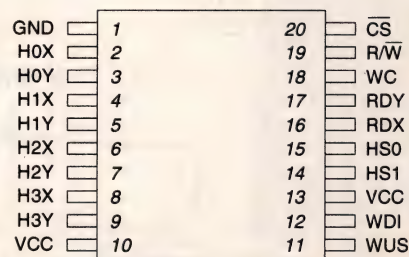
ABSOLUTE MAXIMUM RATINGS

Power Supply: V_{CC}	-0.3 to +7VDC
Write Current I_{W}	60mA
Input Voltages:	
Digital Input Voltage V_{IN}	-0.3 to 5.5VDC
Head Port Voltage V_H	-0.3 to $(V_{CC} + 0.3)\text{VDC}$
WUS Pin Voltage Range V_{WUS}	-0.3 to +6VDC
Output Current:	
RDX, RDY: I_O	-10mA
WUS: I_{WUS}	+12mA
Junction Temperature	150°C
Storage Temperature T_{stg}	-65° to 150°C
Thermal Characteristics, Θ_{JA} :	
20-lead SOIC	80°C/W
20-lead SSOP	TBD

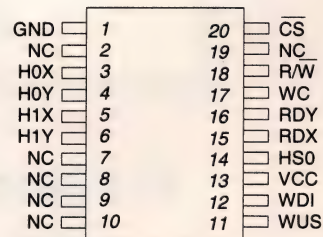
RECOMMENDED OPERATING CONDITIONS

Power Supply Voltage:	
V_{CC}	$+3.3\text{ V} \pm 10\%$
Write current (I_W)	5 to 25mA
Head Inductance (L_H)	0.2 to $5\ \mu\text{H}$
Junction Temperature (T_J)	25°C to 125°C

CONNECTION DIAGRAMS

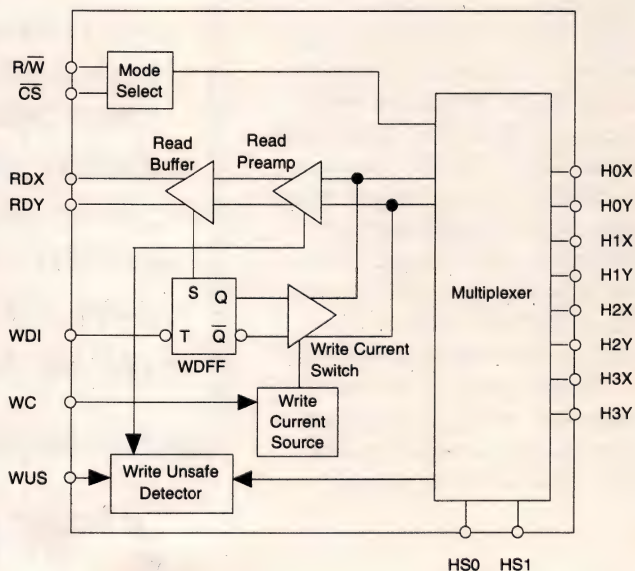


4-Channel
VM3204 20-lead SOIC, SSOP



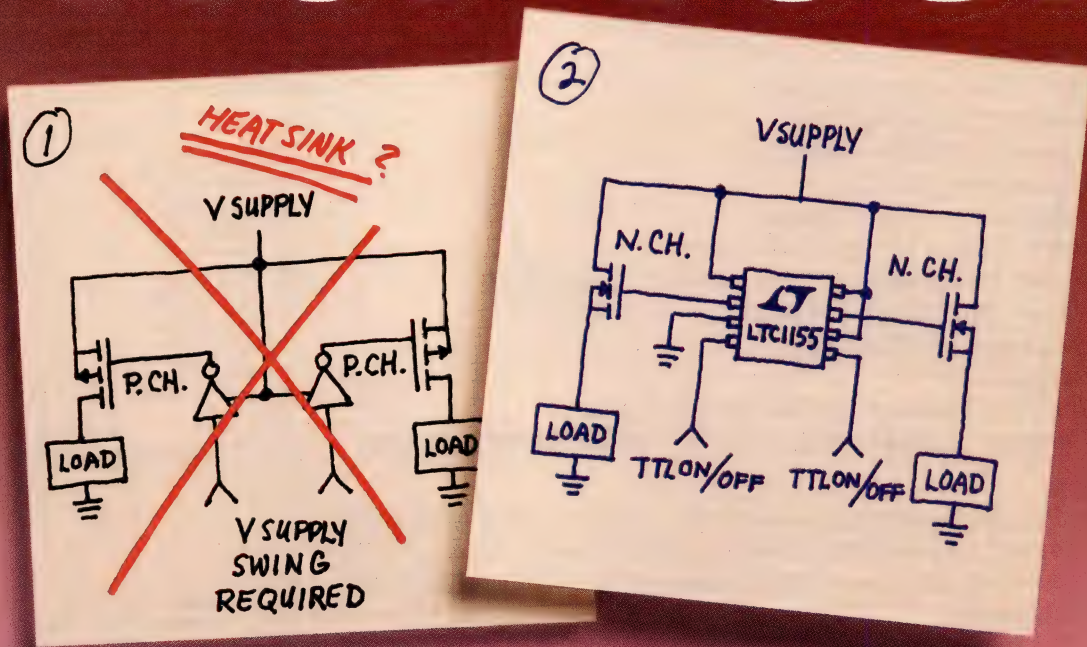
2-Channel
VM3202 20-lead SSOP

BLOCK DIAGRAM



CIRCLE NO. 100

No. Yes.



P-Channel Drop Too High.

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The new LTC1155 is a dual, high-side MOSFET driver designed specifically for battery operated applications such as laptop computers and hand-held instrumentation. By producing a gate voltage higher than the power supply rail, the LTC1155 facilitates the use of low cost, N-Channel MOSFETs instead of larger, more expensive P-Channel parts. It delivers up to 12V of gate drive from a 5V supply. And both channels of the driver include independent short circuit protection.

Gate voltage is generated in a unique on-chip voltage multiplier that requires no external parts! The quiescent current

3

LTC1155

- NO EXTERNAL PARTS
- SPACE SAVING SO-8PKG(DUAL)
- SHORT CIRCUIT PROTECTION
- 8 μ A OFF, 80 μ A ON
- DRIVES LOW COST N-CHANNEL MOSFETS (NO HEATSINKS)
- LOGIC INTERFACE
- CAN USE FOR 24V

drops to 8 μ A when both TTL and CMOS compatible inputs are switched to OFF. A time delay can also be added to prevent false triggering on high in-rush loads.

Operating supply voltage range extends from 4.5V to 18V. The LTC1155 is available now in 8-pin SO or 8-pin DIP. A quad version, the LTC1156, is also available. Prices for 100 piece quantities are \$3.20 for the LTC1155 SO-8 package and \$5.35 for the LTC1156 16-pin SO part. For details, contact Linear Technology Corporation, 1630 McCarthy Blvd., Milpitas, CA 95035 / 408-432-1900. For literature only call 800-637-5545.



TOUGH PRODUCTS
FOR TOUGH APPLICATIONS.

Voltage controls monostable's pulse width

J G Logan and T G Barnett, Queen Mary and Westfield College, London, UK

An external capacitor and resistor usually control the output pulse width of the ubiquitous 4538 precision monostable multivibrator, the width being the product of the resistance and capacitance. However, an external voltage sets the pulse width in Fig 1's circuit. The circuit uses an IL300 (Siemens AG) linear optocoupler operating in the photoconductive mode to generate a precision current that charges the timing capacitor. Thus, the pulse width is set by the value of this current. The IL300 consists of an LED and two matched PIN photodiodes in a bifurcated arrangement. One of the diodes generates a control signal that connects to an op amp acting as a servo driving the LED. This technique compensates for the LED's nonlinear time and temperature characteristics. The optocoupler produces an output current that is linearly related to the voltage applied at the input of the op amp. Note that the output-pulse width is inversely proportional to V_{IN} , but this feature is convenient for many applications.

The control voltage V_{IN} drives the positive input of the op amp. The LM324 op amp operates from a 5V single-rail supply and provides the required current to drive the LED. The op amp supplies enough current to the LED to force sufficient photocurrent through the 25-k Ω resistor to generate a voltage at the negative input of the op amp equal to V_{IN} . The output PIN photodiode current, which is linearly related to the feedback photodiode current, charges the 0.1- μ F timing capacitor of the monostable. Using the component values in Fig 1, control voltages between 0.5 and 2 result in pulse widths between 16 and 4 msec, respectively. You can modify the component values to provide

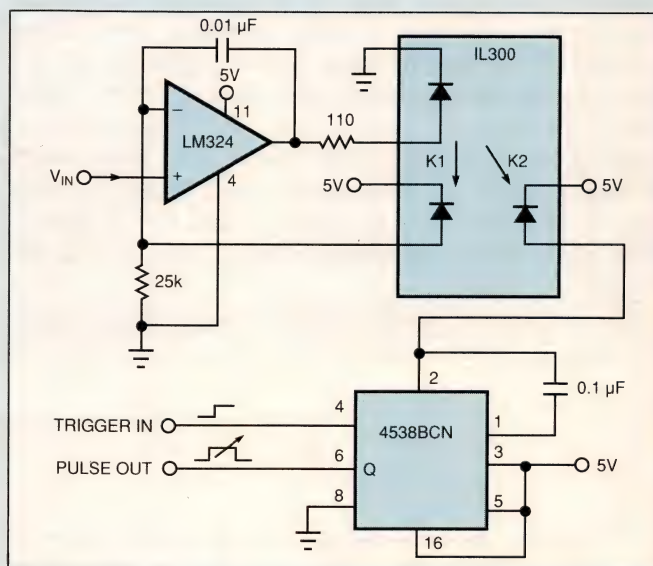


Fig 1—An external voltage, V_{IN} , controls the pulse width of this circuit's 4538BCN monostable multivibrator.

different input-voltage and output-pulse-width ranges. Although this circuit takes advantage of the IL300's ability to generate precise and stable charging currents, you can also take advantage of its primary function, that is, as a fully isolated optocoupler, by operating the control voltage and op amp from power rails that are isolated from the monostable.

EDN BBS /DI_SIG #1159

EDN

To Vote For This Design, Circle No. 715

Low-power clock serves low-speed applications

Rolf Zinniker, Swiss Federal Institute of Technology, Zurich, Switzerland

Fig 1's low-power watch-crystal-based clock generator is especially useful as a real-time clock for battery-powered equipment that uses a microcontroller. In low-speed applications, such as temperature controllers and ambient data loggers, the controller can be off most of the time to stretch battery life. During the off time,

the controller's power-hungry high-speed clock and on-chip timers are not operating. Thus, an additional clock generator is necessary to activate the controller at regular time intervals.

A CD4007, which contains individual transistors, is the active element of Fig 1's generator. The oscillator

stage is an inverter type consisting of Q_1 , Q_2 , R_1 , C_1 , C_2 , and the crystal. Because of the slow rise and fall times of the 32-kHz sinewave input signal, transistors Q_1 and Q_2 are conducting for a significant amount of time, resulting in a high supply current. Bypassing R_2 with C_3 reduces the supply voltage and limits the current to a few μA . Also, the lowest cost 32.768-kHz watch-type miniature crystals prefer a lower drive voltage. In the output stage consisting of Q_3 , Q_4 , R_3 , and C_4 , the circuit restores the signals to full CMOS levels. Because the drive signal from the oscillator stage is low (2 to $3V_{P-P}$), the circuit must introduce a dc shift to drive Q_3 . The simplest, and in fact optimal, way to do this is using C_4 and R_3 as the circuit shows. This clock generator works reliably over a 3 to 6V range.

By dividing the circuit's output using a binary ripple

counter, this circuit can generate output frequencies of 2 Hz to 32 kHz. As supply voltage varies between 3 and 6V, such a circuit would draw between 6 and 18 μA with no load on the divider outputs. At 5V, the circuit draws 60 μW typ. When combining **Fig 1** with a divider, use a CD-series divider and not an equivalent HC part. Because of the slow rise and fall times of the clock generator's output signal, an HC part would draw a much higher supply current (50 to 200 μA) because of lower transistor threshold voltages and higher current capability. Also, when using the CD4007, short the unused N-channel device pins to the negative rail and short the unused P-channel device pins to the positive rail. **EDN BBS/DI_SIG #1160** **EDN**

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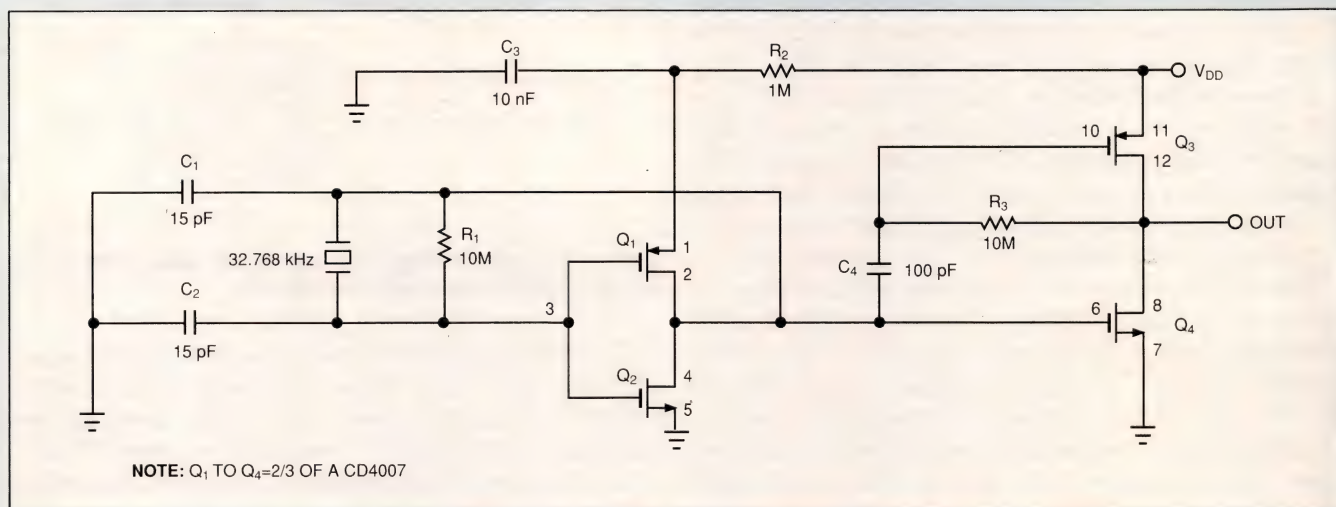


Fig 1—Combining this oscillator with a binary ripple counter creates a 2-Hz to 32-kHz universal clock source.

Battery charges in circuit

J Vandana, SEMP, Tamilnadu, India

Simple as it looks, a battery-charging circuit incorporated within a common thermocouple amplifier makes a world of difference in temperature measurements. You can charge the battery through signal-output cable and reuse the circuit without having to change the leaked-out battery. A 9V NiCd battery (or any other rechargeable battery) located within the amplifier module is good enough for the amplifier to function as a type-K thermocouple amplifier and will measure temperature from 0 to 700°C without degrading the specifications of the thermocouple amplifier, in **Fig 1's** case

an AD595C. The low quiescent current of the AD595C enhances the usability of the battery. After charging the battery, the amplifier becomes a voltage source and can interface easily to any passive voltage meter or recorder without any external power.

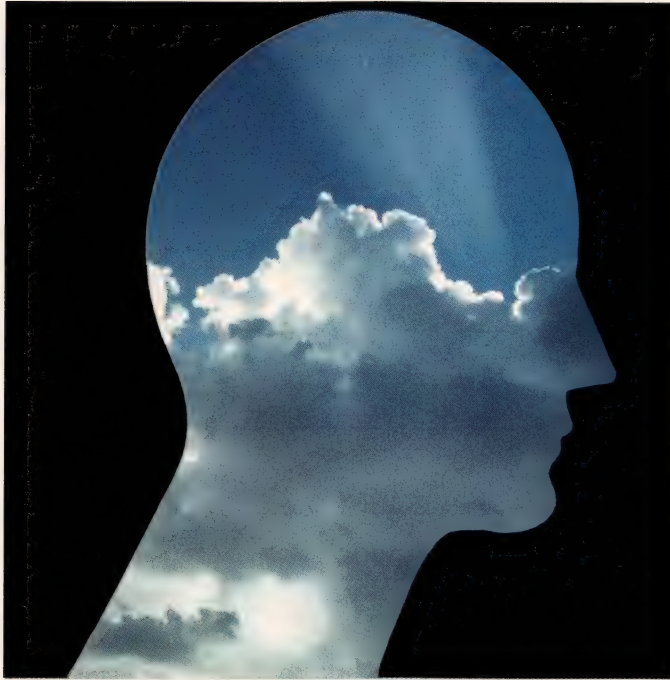
The circuit uses the AD595C for cold-junction compensation and thermocouple signal amplification. An npn transistor, Q_1 , buffers the amplifier's output signal. In charging mode, Q_1 acts as a protection device for the IC. D_2 sources charge to the battery when the circuit is in charging mode. D_1 is a reverse-voltage

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protection device for Q_1 . R_1 is the source resistance for Q_1 and prevents large current from flowing through the AD595C while the circuit is in charging mode. Q_1 also helps reduce the temperature of the AD595C because with Q_1 present, the IC consumes less power to source the output. One caution: a short circuit in the

output cable may prevent the battery from charging.
EDN BBS/DI_SIG #1161 **EDN**

To Vote For This Design, Circle No. 717

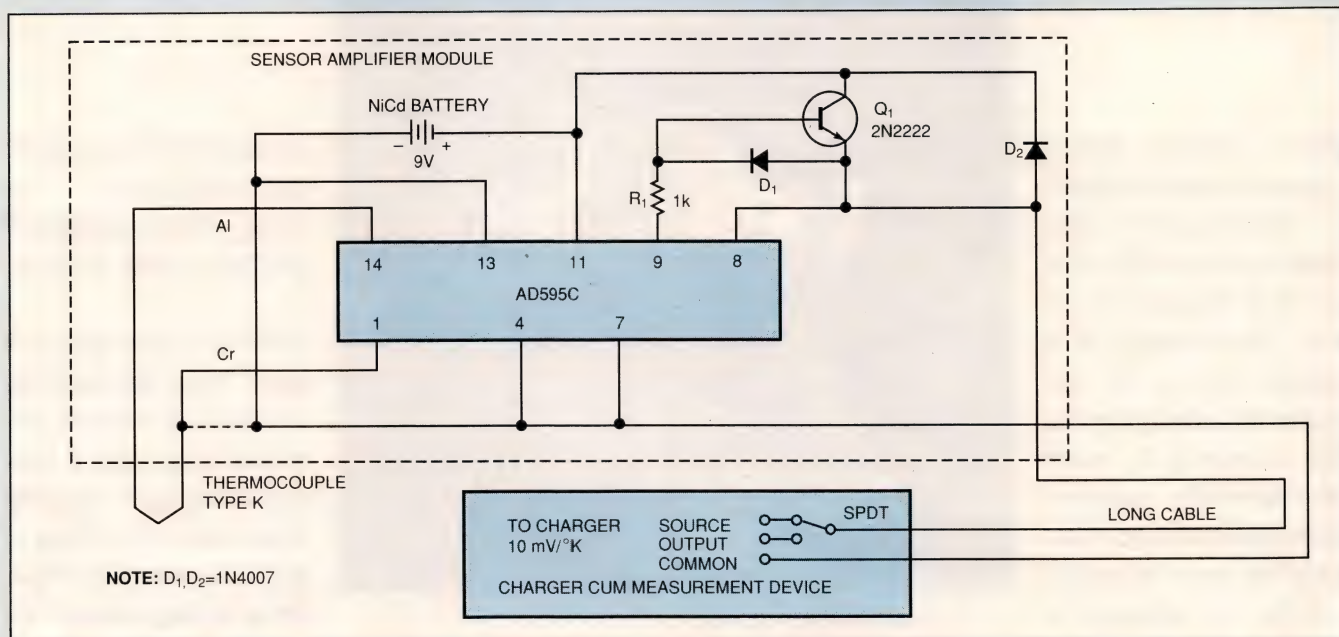


Fig 1—A battery-charging circuit incorporated within a common thermocouple amplifier lets you charge the battery through signal-output cable and reuse the circuit without having to change the leaked-out battery.

Utility tracks PC and DSP-board addresses

Steven J Denny and Stephen J Roome, Data Sciences UK Ltd, Farnborough, Hants, UK



Communication between a PC program and a plug-in DSP board is usually carried out by reading and writing to specific locations within the board's address space. Maintaining consistency between the set of addresses used by the PC program and those used by the program running on the board is important. The most obvious method of ensuring consistency is to create a table containing the relevant addresses and manually check that the two programs use them. For today's large DSP programs with multiple source files written in C and assembler (Ref 1), this checking can require substantial effort by the programmer. It is also by no means obvious when a change to a source file will change the addresses of variables or buffers.

A program called Symbols solves this problem. Symbols takes the names of three ASCII files as param-

Listing 1—Typical Symbol-Table Segment

pitch	0x00093880 extern	short		.buff
init_pitch_estimator	0x00800e40 extern	short		.text
flush_flag	0x00fff018 extern	short		.data
INT_error_count	0x00fff016 extern	short		.data
data_format	0x00fff01c extern	short		.data
stack	0x00fff024 extern	short		.data
pitch_estimate	0x008010cc extern	short		.text
rate_mode	0x00fff01a extern	short		.data
init_record_ISR	0x00801b58 extern	short		.text
cmd	0x00fff004 extern	short		.data
INT_buffer_no	0x00fff012 extern	short		.data

ters. The first file is the symbol table of the DSP program. The format of this file and the method of generating it depend on the DSP processor you're using. For the AT&T DSP32C, the utility d3nm is used.

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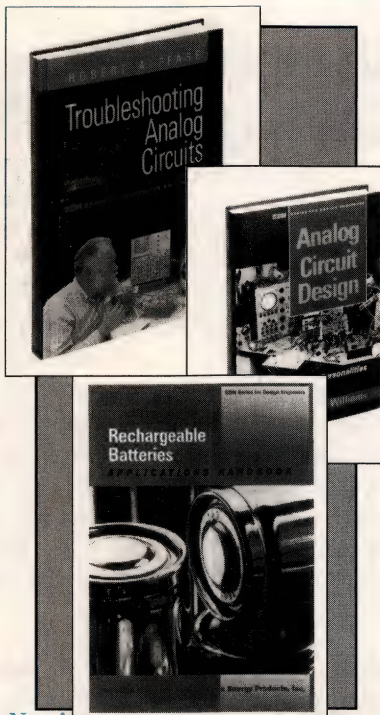
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Listing 1 shows a segment from a typical symbol table.

The second file contains a list of variables separated by spaces or new lines as the following segment illustrates:

```
buffer
buffer_ptr
buffer_status
cmd
```

The third parameter defines the name of an output file. The Symbols program parses each line in the symbol table to obtain the name of a variable and compares it to those in the variable list. If a match is found, the corresponding address is read and used to write a line to the output file. The following shows the equivalent segment of an output file:

```
#define BUFFER_ADDR 0x00080000
#define BUFFER_PTR_ADDR 0x00fff538
#define BUFFER_STATUS_ADDR 0x00fff004
#define CMD_ADDR 0x00fff004
```

This file is in a format that you can include in a C program. For every DSP-board memory location writ-

ten to or read by the PC, a compile time constant has been defined consisting of the variable name in upper case with `_ADDR` appended. The address usage between the two programs will be consistent if:

- the programs use these compile time constants instead of memory addresses;
- you recreate the symbol table and run Symbols for each new DSP executable file;
- you compile every module of the PC program that uses the include file each time it changes.

The best way of ensuring these three requirements is to use a make utility. You'll find a listing of an implementation of Symbols for boards containing an AT&T DSP32C posted on the EDN Bulletin Board. You can readily modify the program to deal with the format of the symbol tables of other DSP processors.

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Reference

1. Denny, Steve and Stephen J Roome, "Combine C and assembler to program powerful DSP processors," *EDN*, April 23, 1992, pg 153.

Diode simulator reduces forward drop to 0.04V

Isaac Eng, ESTCO Battery Engineering, Ottawa, Ontario

To gain higher power efficiency, a lower than 0.7V diode drop is sometimes desirable. **Fig 1's** diode simulator exhibits a voltage drop of 0.04V with 1A of forward current, a reduction of more than tenfold the usual diode forward-voltage drop. Current is normally

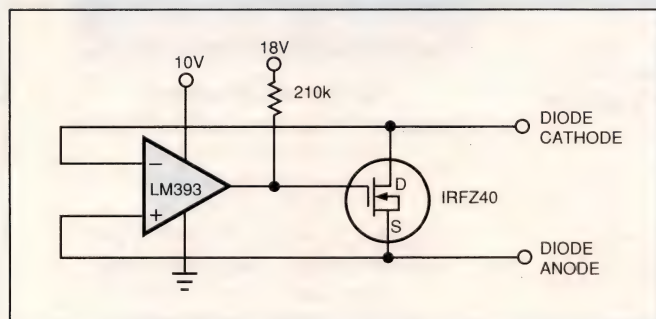


Fig 1—To create a circuit element that emulates a diode with a 0.04V drop, this simple circuit causes current to flow from the source to the drain of the N-channel enhancement MOSFET.

switched to flow from drain to source in an N-channel enhancement MOSFET. In **Fig 1**, however, current flows in the opposite direction, which is the same direction as an intrinsic drain-source diode. When the source is more positive than the drain, the comparator turns on the IRFZ40 FET to conduct current. A forward voltage drop of 0.04V is observed when one amp passes through the simulated diode in the forward direction. When the drain is more positive than the source, comparator LM393 outputs a low value, which turns off the FET's current flow. Hence, current conducts in only one direction. The drain and source voltage must be within 0 and $V_{CC} - 1.5V$, which is the input range of the comparator. The 210-k Ω resistor is a pullup resistor for the open-collector comparator.

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EDN-DESIGN IDEAS

Feedback & Amplification

Circuit uses fewer parts than previous idea

Based on the Design Idea "Battery-powered μ P turns itself off" in the January 20, 1992, edition of EDN (pg 133), the following circuit can achieve the same goal with fewer components. Using the CS8140 or CS8141 watchdog regulator from Cherry Semiconductor Corp, the circuit in Fig 1 is ideal for short power-on cycles because it lets the μ P take control of its own power-down sequence.

The momentary contact switch charges C_1 quickly through R_1 . When the voltage across C_1 reaches 3.95V typ, the enable activates and V_{OUT} goes to 5V. The external capacitor C_2 sets the reset delay. After the delay period, the watchdog regulator generates a frequency-programmable pulse train at the reset pin until the correct watchdog signal appears at the WDI pin. C_1 discharges through the enable input, which contains a 150-k Ω internal resistor. When the μ P has finished its routine, the watchdog signal will cease. The regulator generates a reset signal and goes into a sleep mode with $V_{OUT}=0$, thus shutting down the μ P.

Kieran O'Malley

Cherry Semiconductor Corp

2000 S County Trail

E Greenwich, RI 02818

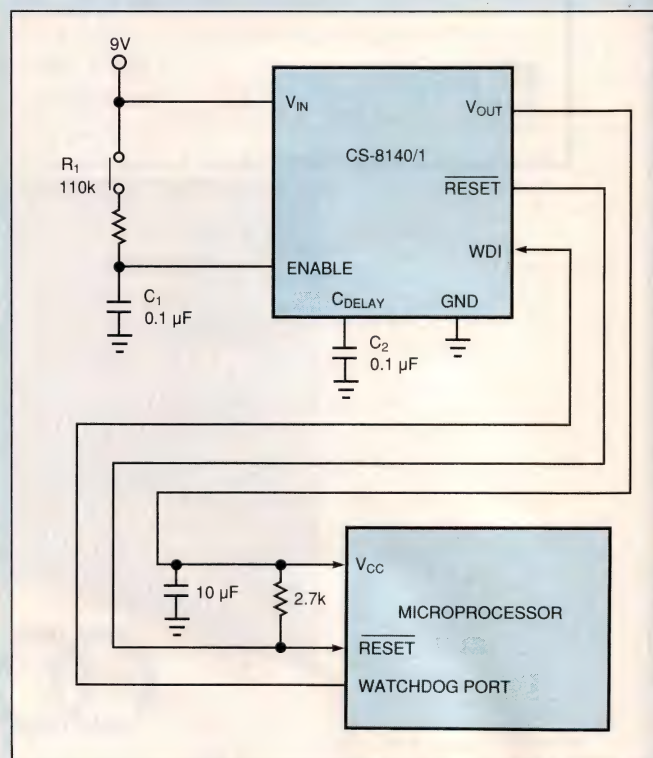


Fig 1—This circuit uses fewer components than a similar idea published in the January 20, 1992, edition of EDN.

Corrections

"AC supply lights cold-cathode fluorescents," by Jim Williams, *EDN*, March 2, 1992, pg 140, DI #1091: Pin 3 of inductor L_1 should connect to the positive supply. "Buffer goes solo in fast active filter," by Michael Se-dayao, *EDN*, March 30, 1992, pg 138, DI #1096: The op amp's negative supply should also have a 0.1- μ F bypass capacitor. And, the equation given for f_0 is missing a π ; it should read

$$f_0 = \frac{K}{2\pi RC\sqrt{mn}}$$

"Paralleled amplifiers drive loads quietly," by Moshe Gerstenhaber and Mark Murphy, *EDN*, April 23, 1992, pg 171, DI #1118: The equation

$$V_N = \frac{1}{4}\sqrt{4(V_{N1})^2}$$

should be

$$V_N = \frac{1}{4}\sqrt{4(V_{N1})^2}$$

"ADC/DAC combination finds square roots," by Jeff Kirsten, *EDN*, April 23, 1992, pg 186, DI #1073: The correct part number of the DAC is a MAX543. The voltage attached to the potentiometer R_1 should be labeled V_{IN} (0 to -5V), not V_{OUT} as drawn. Note also that the origin in the scope photo is in the lower right corner.

How to use our bulletin board



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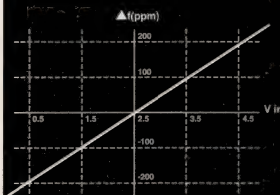
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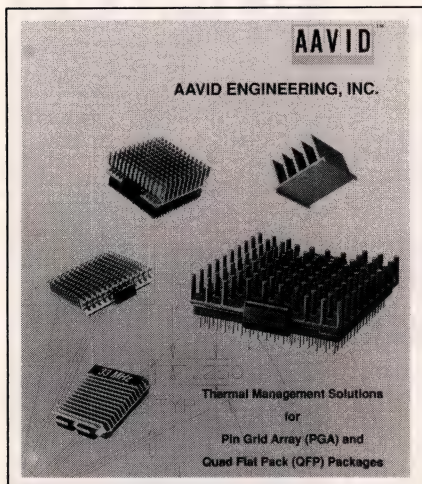
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The 12-pg catalog presents heat sinks for Intel 80486 and Motorola 68040 μ Ps. It also contains a range of other PGA (pin-grid-array) products and attachment methods for dealing with thermal-management problems. The publication tells you how to solve cooling problems, using recently formulated technologies. In addition, it discusses vacuum die-cast heat sinks for 3-D capabilities and electrically insulating attachment clips made from a special composite material.

Aavid Engineering Inc, Box 400, Laconia, NH 03247. Phone (603) 528-3400. FAX (603) 528-1478. TWX 510-298-1127.

Circle No. 427

Controllers For Fans

This 24-pg catalog deals with Smartfan controllers for sensing temperature inside fan- or blower-cooled equipment. It also covers devices for controlling speed to keep temperature constant. It describes Miniwisp, Wisp, Omni L, Multi L2, Omni S, Multi S, AC-K, and AC-N controllers. The table of contents guides you to sections on temperature alarms, sensors, custom controllers, designing with Smartfan, derating data, installation and testing, technical data, and cooling-system noise control. The selection

guide lists specifications for the eight controller models.

Control Sources Inc, Box 315, Harvard, MA 01451. Phone (508) 772-4043. FAX (508) 772-4142.

Circle No. 428

Guide To Hardware Products And Systems

The Masterlog provides black-and-white photos and descriptions of past issues of hardware-product catalogs. Some of the products listed in the table of contents include terminals and splices; pin and socket connectors; pc-board connectors; coaxial and flat-coaxial cable products.

AMP Inc, Product Information Center, Harrisburg, PA 17105. Phone (800) 522-6752; (717) 564-0100. TWX 510-657-4110.

Circle No. 429



Publication Describes Fans And Blowers

This listing of fans and blowers introduces several products: the 2.4-in. series of tube axial fans; the variable-speed "Variofan" group of air movers; ac and brushless dc 5.3-in. tube axial fans; ac and brushless dc 6.8-in. tube axial fans in 1.5-in. and 2.2-in. thicknesses; and the ac and brushless dc "Flatpack" series

of blowers available in three sizes. Descriptions, photos, diagrams, specifications, features, and graphs complete the catalog.

Papst Mechatronic Corp, Aquidneck Industrial Park, Newport, RI 02840. Phone (401) 849-8810. FAX (401) 849-4640. Circle No. 430

Presentation Of VLSI And Surface-Mount Adapters

The World's Largest Collection of VLSI and Surface-Mount Adapters and Accessories presents 142 pages of emulator pods and adapters, debug tools, programming adapters, socket converters, debugging accessories, and prototyping adapters. The publication provides sections on how to use the catalog, custom orders, new products, footprints, and product specifications. Also included are a glossary, an order form, and a list of international distributors.

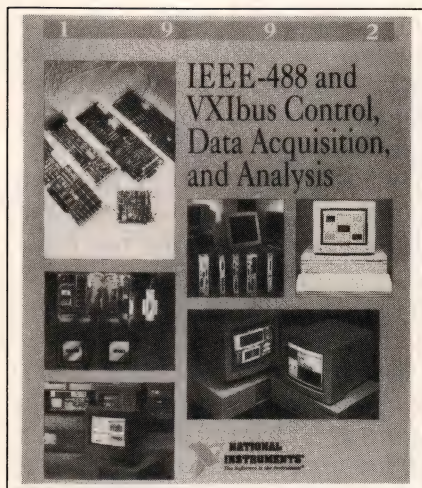
Emulation Technology Inc, 2344 Walsh Ave, Bldg F, Santa Clara, CA 95051. Phone (408) 982-0660. FAX (408) 982-0664. Circle No. 431

Hardware Assortment

The 920 catalog covers more than 35,000 products including fiber-optic, telecommunications, and single in-line memory-module (SIMM) socket-interconnect, switch devices, and RF coaxial connectors. The publication gives product descriptions, specifications, photos, drawings, ordering information, and a directory of company distributors and representatives worldwide. Other products in the publication include pin-and-socket connectors, microconnectors, application tooling, solderless terminals, and environmental and I/O connectors.

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Catalog of software and hardware

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Brochures on software development tools and ICEs

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Embedded software standards

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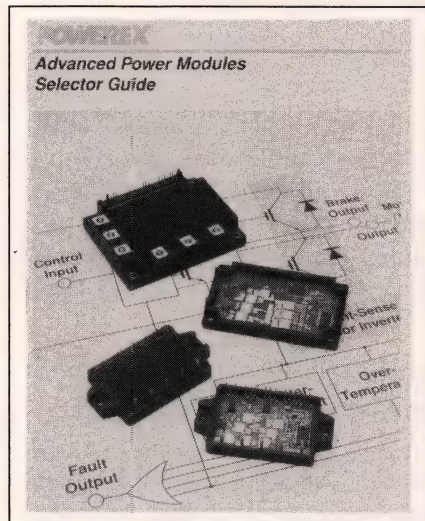
This 58-pg publication describes the 387 SL mobile math coprocessor, which is an extension of the 386 SL and SX μ P architecture. The booklet is divided into nine sections: Pin Assignment; Functional Description; Programming Interface; Hardware-System Interface; Bus Operation; Package Specifications; Electrical Characteristics; Intel387 SL Mobile Math Coprocessor Instruction Set; and Revision History. Three appendices list Programmer's Reference Manual Updates; Intel387 SL Mobile Math Coprocessor Compatibility; and Compatibility Between the 80287 and 8087 Math Coprocessor. The booklet also provides numerous tables and figures.

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icons to summarize the key features of each product; it provides product-comparison charts, specifications, flow charts, and photos.

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cuits, DACs, and ADCs, and concludes with test techniques. The packet's five color brochures cover high-performance D/A converters, high-speed linear products, operational amplifiers, instrumentation amplifiers, and isolation products. The pamphlets describe the products and include specifications, tables, schematics, graphs, drawings, selection guides, and photos.

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Digital-Signal-Processing Databook

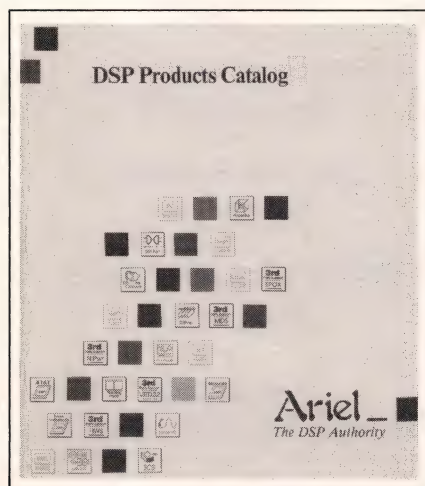
This databook describes DSP products for commercial and military applications and includes application notes. It also summarizes 1- and 2-D filters, multipliers, signal synthesizers, and special-function devices.

Harris Semiconductor, Box 883, Melbourne, FL 32901. Phone (407) 724-3704. Circle No. 421

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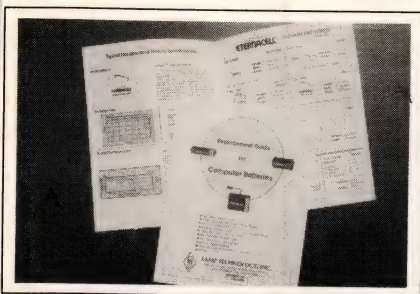
Analog Devices, Literature Center, 70 Shawmut Rd, Canton, MA 02021. Circle No. 422



Offering Of DSP Products

The DSP Products Catalog describes devices for PC-based DSP chips (digital signaling processing) such as the DTK-C25 TMS320C25 developer's tool kit. The catalog also covers products for SPARCstation SBus DSP, Macintosh II DSP, Hewlett-Packard Series 200/300 DSP, Next DSP, DSP ports, and VME. The 56-pg publication uses

Power Sources



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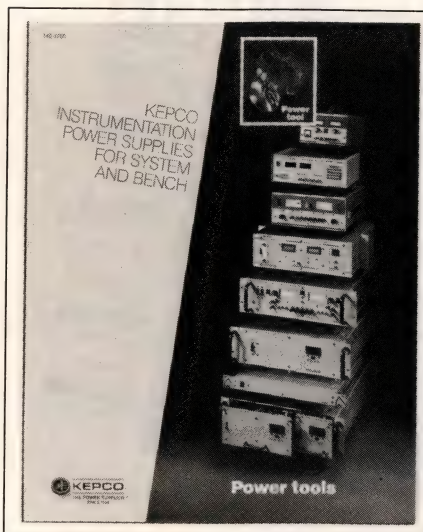
Two catalogs deal with uninterruptible power systems, power conditioners, and power supplies. The first catalog, a 28-pg publication, discusses protection products for DOS, Windows, Unix/Xenix, Net-Bios, Novell, Microsoft, LANtastic, 3Com, and Banyan systems; it also explains surges, sags, spikes, brownouts, electronic noise, and odd-order harmonics for office and industrial environments. The other catalog's 24 pages list company-specific power supplies and provide application notes, schematics, charts, tables, and diagrams that complement product photos and ordering information.

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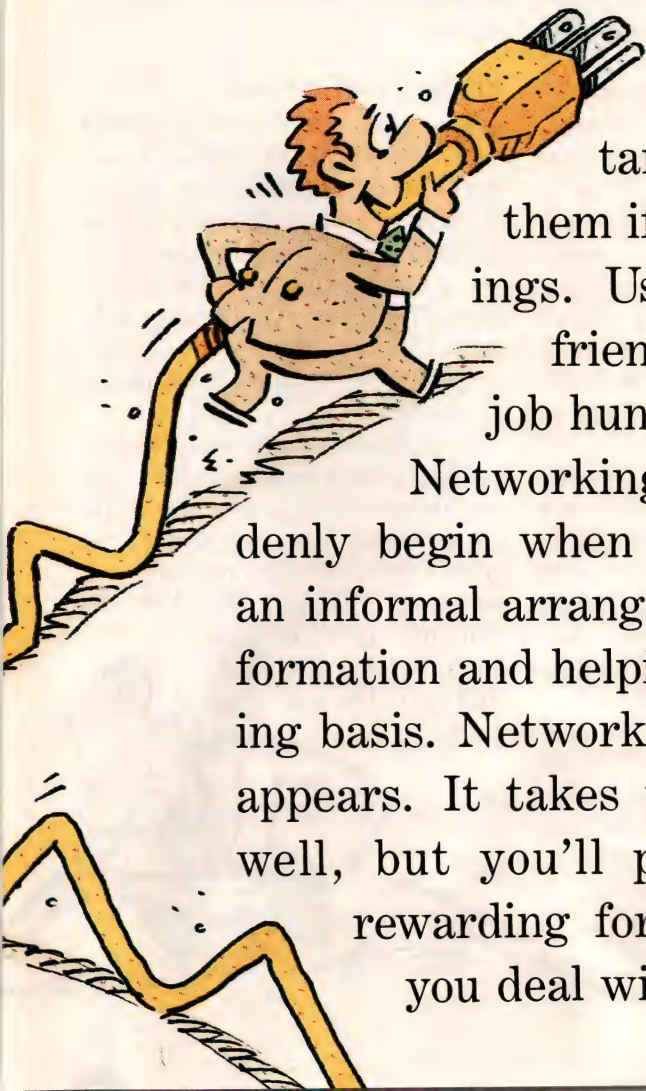
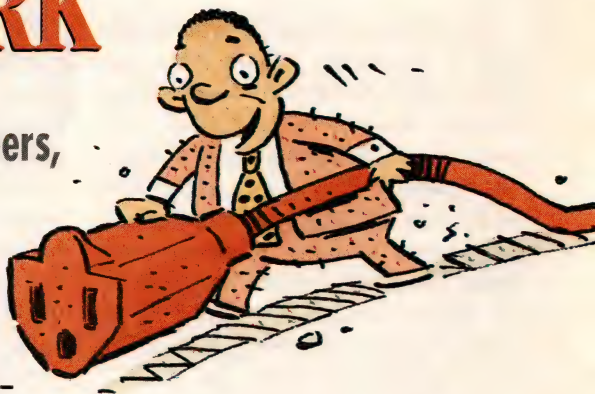
Jay Fraser, Associate Editor



any people think of networking only after they've been laid off or fired.

Then they desperately call every friend and acquaintance they can think of, asking them if they know of any job openings. Usually there are none, the friends feel pressured, and the job hunter ends up frustrated.

Networking isn't something you suddenly begin when an emergency strikes. It's an informal arrangement of people sharing information and helping each other on a continuing basis. Networking also isn't as simple as it appears. It takes time and planning to do it well, but you'll probably find networking rewarding for you and the people you deal with.



Illustrations by Elwood Smith



The primary benefit of networking is acquiring information. Rebecca Hayes, president of Career Action Associates in Dallas, TX, and an experienced career counselor says, "People get about 75% of all jobs through some kind of networking, through someone they know, or through more active forms of direct networking. Only about 25% of jobs come through employment agencies or want ads."

But the information you gain through networking won't be limited to news about jobs. You'll find out about developments in your engineering speciality and in the profession as a whole. You'll hear about products before they're officially introduced. You may even learn about what's going on in your own company. "When you talk about networking," says Hayes, "you're really talking about a network of information."

Another benefit of networking is that it helps you gain recognition in the firm where you work and in wider engineering circles. Establishing a reputation as a knowledgeable and reliable person will improve your chances for advancement. In addition, because of your increased visibility people will seek you out, and

your network will grow quickly.

Being a part of a network also means help is available if you ever need it, not just after you've lost your job. That help can range from using someone's name in a letter so it will get prompt attention, to having someone arrange an interview for you.

But don't forget, networking is reciprocal. You may be called on to provide introductions and recommendations, to be a reference, or to help someone more directly. If you come across information you think may be of interest to people you know, call them up and tell them about it. They'll appreciate the favor and return it sooner or later.

Networks are made up of people. Every day you come in contact with people, perhaps dozens of them, who could be part of your network. All you have to do is take them into your confidence.

Start building your network with people in your profession, the engineers you work with now and have worked with in the past. Think of the engineers you were friendly with who have left your present company and the ones you worked with in other companies. Don't worry if you've lost touch with them. Give them a call or write them. They'll probably be happy to hear from you.

Next, consider other people who are involved in your work but may not be engineers. You probably deal with clients and vendors to some extent. They can be valuable sources of information, and they may have an overview of the high-tech industry that you lack.

Professional organizations provide excellent opportunities for networking. If you're not a member of a professional organization, join one. If you're already a member of a professional organization, become more

active in it. You could volunteer for a committee, present a technical paper, even run for office. The more involved you become, the more people you will meet.

However, don't limit your network to people involved in engineering. People outside your profession can also prove valuable. You can meet them through fraternal organizations, alumni associations, or community-service organizations.

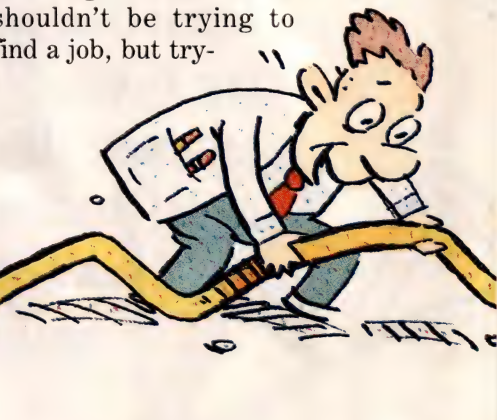
If you graduated from college recently, stay in touch with your professors and advisors. Often people in the academic world do consulting work and have good contacts in industry.

Finally, don't forget your friends, relatives, and people you meet socially. You may be surprised by whom they know. Sometimes information or help can reach you in a roundabout way. Don't overlook anyone.

Building your network

You may face special problems when you set out to develop a network. Many engineers are uneasy in social situations or when they're meeting new people. Kendall Dudley is the founder of Lifeworks, a consulting firm in Cambridge, MA, that deals with career and life planning. He has had many engineers as clients.

"Certain kinds of corporate engineering favor intense specialization and introversion. That's wonderful for producing a product, but not so good for supporting one another," he says. "The first phase of networking in this case shouldn't be trying to find a job, but try-



ing to establish yourself within a broader landscape than where you are. Engineers should talk with people they wouldn't usually encounter to provide some kind of context in which they can think more creatively about their work and their lives."

The traditional methods of getting to know people—inviting them out for lunch or for a drink after work—may not work for an engineer who's shy around strangers. "Lunch is a social activity, and sometimes people can spend so much time on the mechanics of going to lunch that they don't get very much good information," says Hayes.

"For people just starting out, I'd recommend sending a letter to the people you'd like to meet, explaining what kind of information you'd like to talk about. Indicate to them that you're not looking for a job and arrange a specific time to go to their office and meet them face to face. And put a time limit on it. Tell them you only want 10 or 15 minutes of their time. That will force you to be more organized and stick to the point."

Traditional methods still work

If you don't freeze up in social situations, the tried and true methods will probably work for you. Make it a habit to go out to lunch with someone two or three times a week and invite different people each time. Don't isolate yourself in a small circle of friends or become associated with a clique.

When you talk to people don't try to pump them for information. If you're contemplating a job change, ask people for their advice. For example, ask them if they know of a

good executive placement service or if they've been employed by another company and what it was like to work there. Networks grow at their own pace. Don't try to build one through brute force.

It should go without saying that in these conversations you don't reveal confidential information. Also, you should not repeat rumors or stories you can't substantiate. A reputation as a gossip isn't going to do you any good.

Whenever you talk to people for the first time be sure to ask them for the names and phone numbers of other people to call. "It's important to get leads," says Robert Chope, a psychologist and founder of the Career and Personal Development Institute in San Francisco, CA. "The best way to start your network is to generate lists of everyone you know, then target the people who will be most useful to you. Ask each person to give you three to five more names to contact. After you've talked to them you can begin to do things like information interviewing. But the initial priority is numbers."

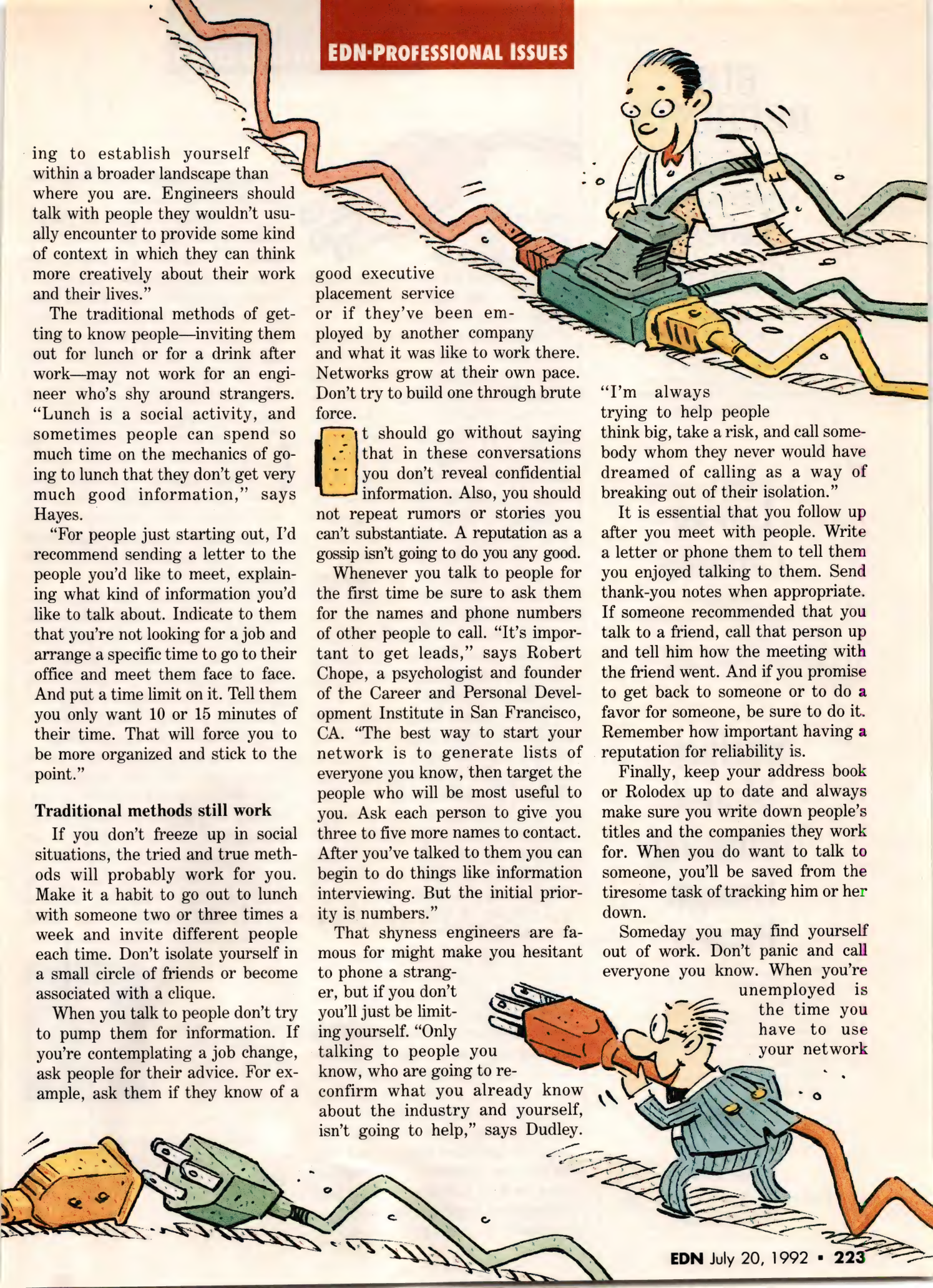
That shyness engineers are famous for might make you hesitant to phone a stranger, but if you don't you'll just be limiting yourself. "Only talking to people you know, who are going to reconfirm what you already know about the industry and yourself, isn't going to help," says Dudley.

"I'm always trying to help people think big, take a risk, and call somebody whom they never would have dreamed of calling as a way of breaking out of their isolation."

It is essential that you follow up after you meet with people. Write a letter or phone them to tell them you enjoyed talking to them. Send thank-you notes when appropriate. If someone recommended that you talk to a friend, call that person up and tell him how the meeting with the friend went. And if you promise to get back to someone or to do a favor for someone, be sure to do it. Remember how important having a reputation for reliability is.

Finally, keep your address book or Rolodex up to date and always make sure you write down people's titles and the companies they work for. When you do want to talk to someone, you'll be saved from the tiresome task of tracking him or her down.

Someday you may find yourself out of work. Don't panic and call everyone you know. When you're unemployed is the time you have to use your network



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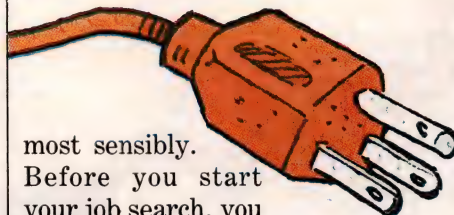
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most sensibly.

Before you start your job search, you should also be aware of some of the difficulties you might encounter because you're an engineer.

"Engineers are unique to the extent that they're very well focused," says Chope. "They become focused on a few things in the career world, and if you take those things away from them you create any number of problems. Usually they've never thought about other ways of applying their engineering training, so they'll beat themselves over the head trying find a job similar to what they've been doing."

Just as you can overuse your network, you can also underuse it. Because of embarrassment, some people don't want to admit that they've lost their jobs. They're reluctant to call their contacts just when they need them the most.


"People don't like to ask other people for help, especially when they're out of work. That's the toughest part of networking," says Chope. "You have to say I was laid off or I was fired or I had a conflict with someone. In occupations like engineering, even your best friends will wonder if there's something wrong with you. That's why people feel they're at risk when they're networking."

Overusing and underusing your network are both common mistakes, and so is relying on your network exclusively. A network isn't a job-placement service. Don't pin all your hopes on it. You should pursue all the usual methods of looking for work and consider networking one part of a larger process.

"Do anything you can think of—network, get your resume to a couple of good recruiters, answer any ads that look pertinent, go to your professional organization meetings. Respond to everything, because

one of them is going to turn up your next job," says Hayes.

"The biggest mistake people make is not keeping busy," she adds. "They tend to do things like send out a broadcast letter with a resume attached, then sit at home and wait for the phone to ring. There's a lot of dead time, and people get very depressed and frustrated. You should generate as much activity for yourself as you would working a full-time job."

 If you build it carefully and use it well, a network can be very helpful, especially when you're looking for work. But how helpful your network is ultimately depends on you, and a large part of your success in finding a job will be your attitude.

"We tend to see the negative—the 10% who are out of work or the neighbor who just got the shaft last week—but it's really important to keep an optimistic perspective. It gives us more courage to enter into a network and use it in a more creative, vibrant way," says Dudley.

"If you understand the whole process that's involved in networking, which means reaching out, talking to people, pursuing leads, thinking big thoughts, being open to a change in your career and in yourself, then I think networking can be a primary tool and one that can't be used enough." **EDN**

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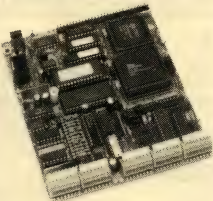
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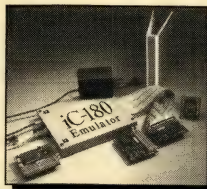
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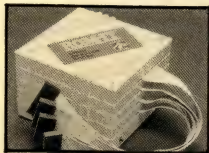
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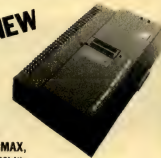
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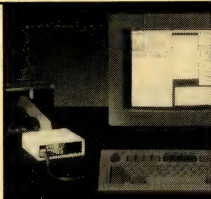
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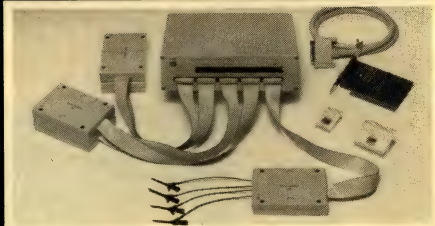


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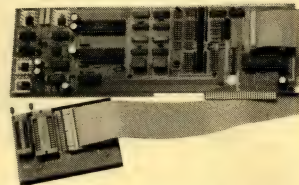
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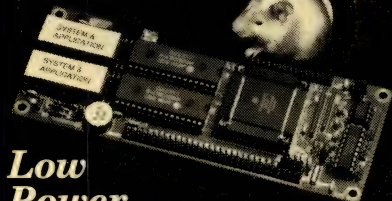
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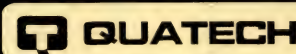
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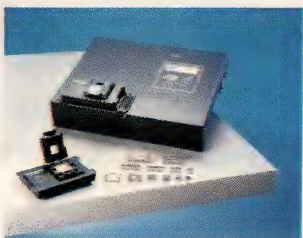
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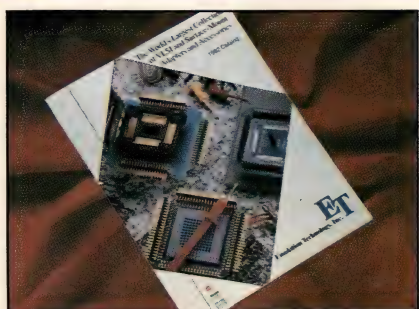



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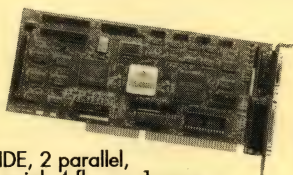
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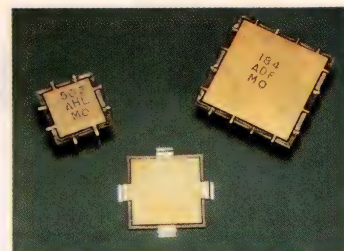


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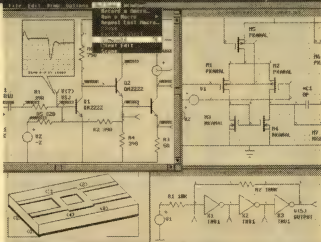
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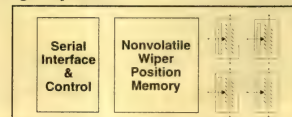
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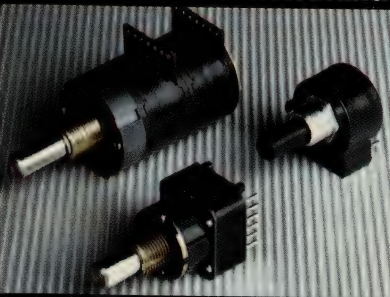


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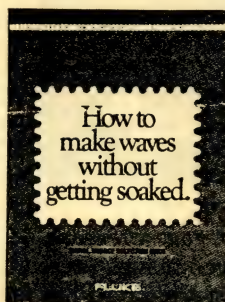
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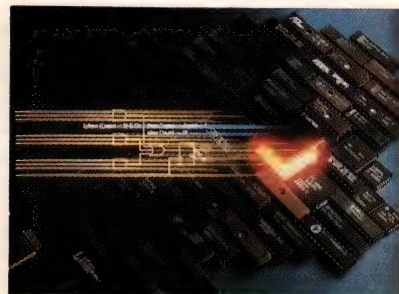


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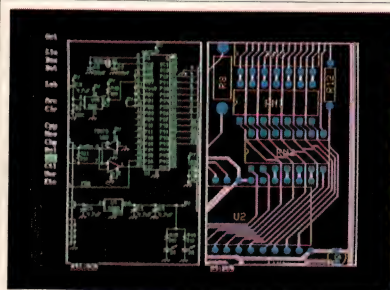
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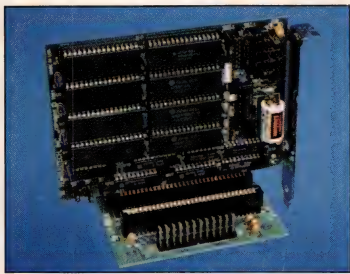
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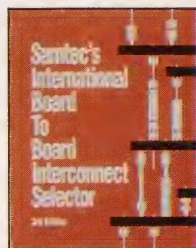
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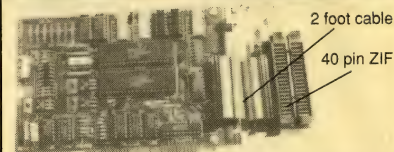


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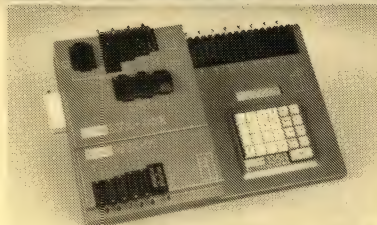
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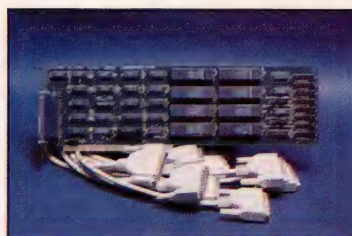
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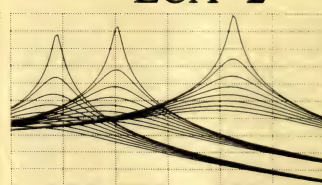
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Issue	Issue Date	Ad Deadline	Editorial Emphasis
Magazine Edition	July 20	June 25	INTERNATIONAL PRODUCT SHOWCASE—Vol. II Computers & Peripherals Components • CAE • Test & Measurement
News Edition	July 23	July 9	Engineering PCs & Workstations • CAE Software SIGGRAPH Hot Products Graphics Technology • Engineering Management Special Series • Regional Profile: Arizona, New Mexico
Magazine Edition	Aug. 6	July 16	Microprocessor Development Tools • ICs & Semiconductors Technical Article Database Index EDN's "Innovation Crusade"—Finalists Coverage • Reader Vote Contest: All advertisers in the issue qualify
News Edition	Aug. 13	July 30	DSP ICs • EDN's "Innovation Crusade"—Finalists Coverage Telecom Software • Engineering Management Special Series
Magazine Edition	Aug. 20	July 30	MILITARY ELECTRONICS SPECIAL ISSUE • Military Computers Design • Test & Measurement • Memory Technology • Components
News Edition	Aug. 27	Aug. 13	Embedded Software • Software • Regional Profile: Washington DC, Maryland, Virginia
Magazine Edition	Sept. 3	Aug. 13	ASICs SPECIAL ISSUE CAE Tools & Techniques Computer Peripherals • Computer Buses • Sensors & Transducers • Buscon Show Coverage
News Edition	Sept. 10	Aug. 27	CAE • Test & Measurement Diversity Special Series
Magazine Edition	Sept. 17	Aug. 27	Field-Programmable Gate Arrays DSP Directory • Embedded Computers • CAE
SOFTWARE ISSUE	Sept. 17	Aug. 27	SOFTWARE ENGINEERING SPECIAL ISSUE (To be polybagged with the Sept. 17th Magazine Edition issue)
News Edition	Sept. 24	Sept. 10	Automotive Electronics Sensors • Computers & Peripherals • Regional Profile: Oregon, Washington
Magazine Edition	Oct. 1	Sept. 10	TEST & MEASUREMENT SPECIAL ISSUE • European Technology Update • Data Acquisition Software • Superconductors • How to Design it Right the 1st Time Series—Part I PLD/FPGA Directory
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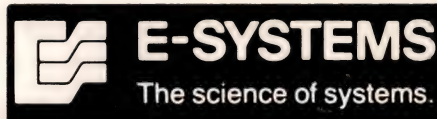
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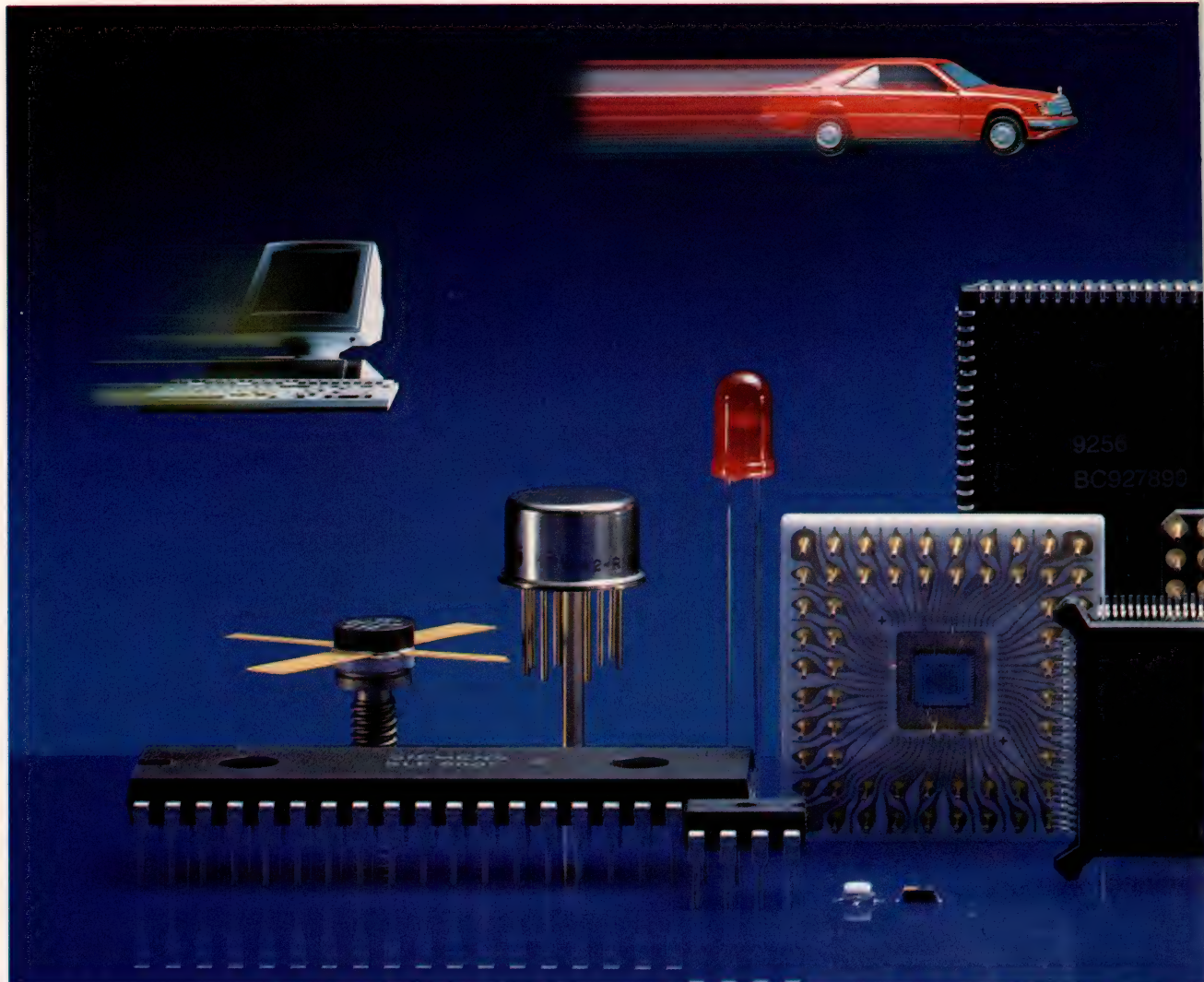
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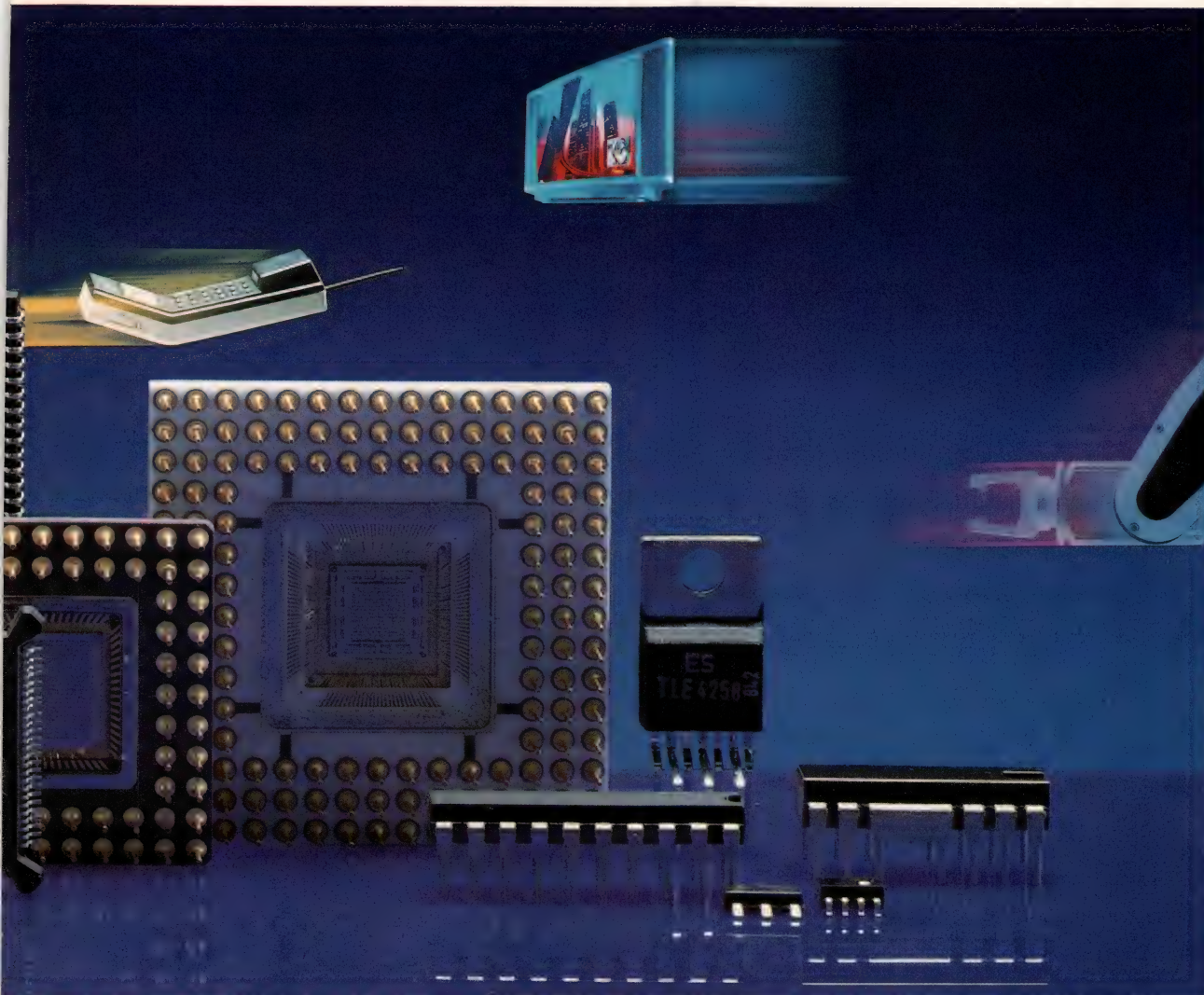


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EDN-ACRONYMS & ABBREVIATIONS

ADC—analog-to-digital converter
ANSI—American National Standards Institute
ASIC—application-specific integrated circuit
BiCMOS—bipolar complementary metal-oxide semiconductor
bps—bits per second
CAE—computer-aided engineering
CAL—common application language
CEBus—consumer electronics bus
CEG—Consumer Electronics Group
CMOS—complementary metal-oxide semiconductor
CSMA—carrier-sense multiple access
DAC—digital-to-analog converter
DMM—digital multimeter
ECL—emitter-coupled logic
EDIF—electronic design interchange format
EEPROM—electrically erasable programmable read-only memory
EIA—Electronic Industries Association
EMF—electromotive force
FET—field-effect transistor
IEEE-488—the Institute of Electrical and Electronics Engineers' standard for communication with instruments; the bus that incorporates the standard
I/O—input-output
ISA—Industry Standard Architecture
LAN—local-area network
LED—light-emitting diode
LON—local operating network
MAC—media-access control
MOSFET—metal-oxide-semiconductor field-effect transistor
NDL—net description language
OSI—open systems interconnection (reference model)
PC—personal computer
PWM—pulse-width modulation
RAM—random-access memory
RF—radio frequency
ROM—read-only memory
RS-232C—an Electronic Industries Association standard for serial communications
SMT—surface-mount technology
SNVT—standard network variable types
STD Bus—a low-cost industrial computing bus
TC—temperature coefficient
TCR—temperature coefficient of resistance
UUT—unit under test
VCR—video cassette recorder
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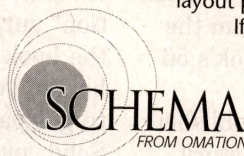
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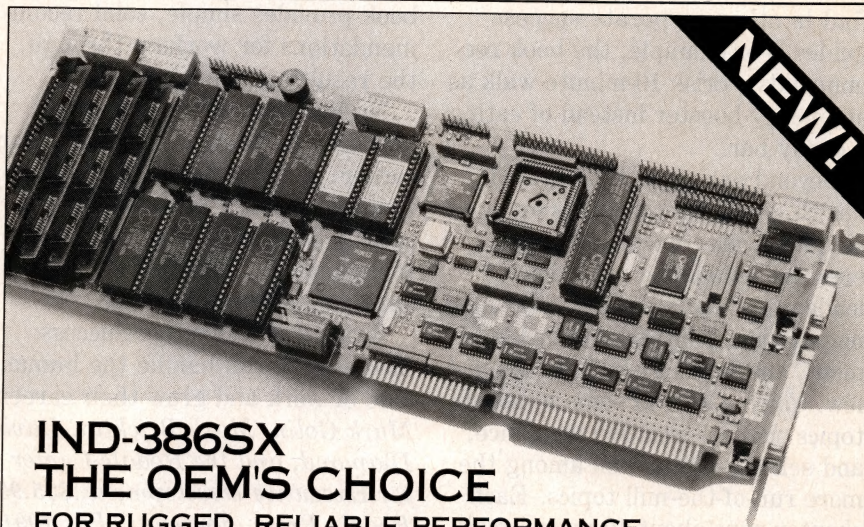
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Because Rodale Press published this book, you'll find mandatory chapters on health and nutrition gleaned from that publisher's better-known publication: *Prevention* magazine. These chapters contain a wealth of tips that you won't find in other corporate success guides. For example, the book recommends a brisk 10-minute walk as an energy booster instead of eating a candy bar.

Beyond eating, nutrition, and health, you'll find chapters on more obvious work topics: delegation, enemies, etiquette, interviews, leadership, management, meetings, negotiation, politics, time management, and writing skills, to name a few. You'll also find some unusual topics such as intuition, romance, and self-esteem hidden among the more run-of-the-mill topics. Each chapter runs about 10 pages, making the book an excellent tool for chinking the spare minutes you may scrounge each day for reading.

This book not only discusses a large number of diverse topics, it also gives you excellent, practical advice for most of these topics. The chapter about self-esteem, for example, lists 10 things you can do each day to feel good about yourself such as "be a kid again," "expand your horizons (look beyond your

own problems)," and "accomplish something small that you've been avoiding." None of these bits of advice are going to remake you into a captain of industry, but they will drag you out of dronelike monotony.

More practical readers will probably appreciate chapters like the one on public speaking. This section advises that you only have to survive the first 30 seconds of a speech. During that time, your pulse may race from a norm of around 70 beats/sec to 190. After the first half minute the "confrontation" surge passes. Consequently, the book recommends that you rehearse your introductory remarks to get past that 30-second surge. Solid, practical advice.

One of the book's best chapters is the one on difficult people. Every organization has them, and you'll eventually work with one, work for one, or supervise one. Again, the book provides simple, solid recommendations for working through the resulting problems.

No book can cover everything you need to know throughout your career, and this book is no exception. However, I have not read a similar book with so many useful hints and tips for organizational survival.—**Steven H Leibson**

Secrets of Executive Success: how anyone can handle the human side of work and grow their career, Mark Golin, Mark Bricklin, David Diamond, and the Rodale Center for Executive Development, \$35.95, Rodale Press, Emmaus, PA, 1991, 474 pg.

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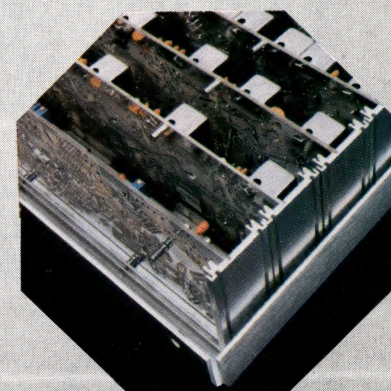
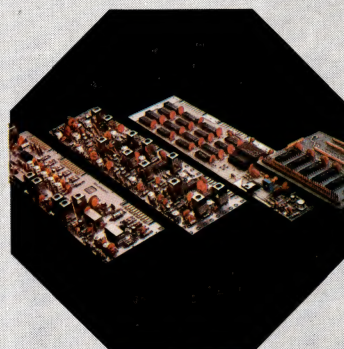
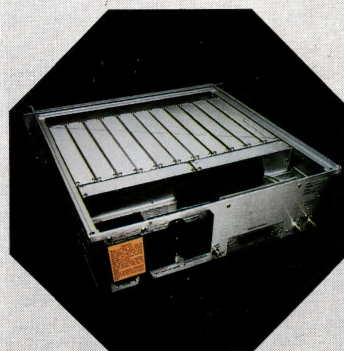


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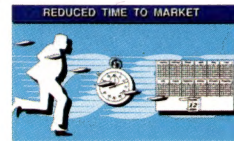
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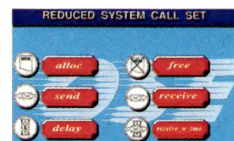
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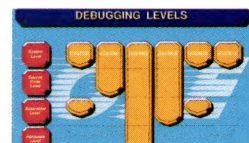
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